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METALS and ALLOYS

The Engineering Magazine of the Metal-Working Industries

VOLUME 20 • NUMBER 3 • SEPTEMBER, 1944

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A STRONG COMBINATION
in powder metallurgy . . .

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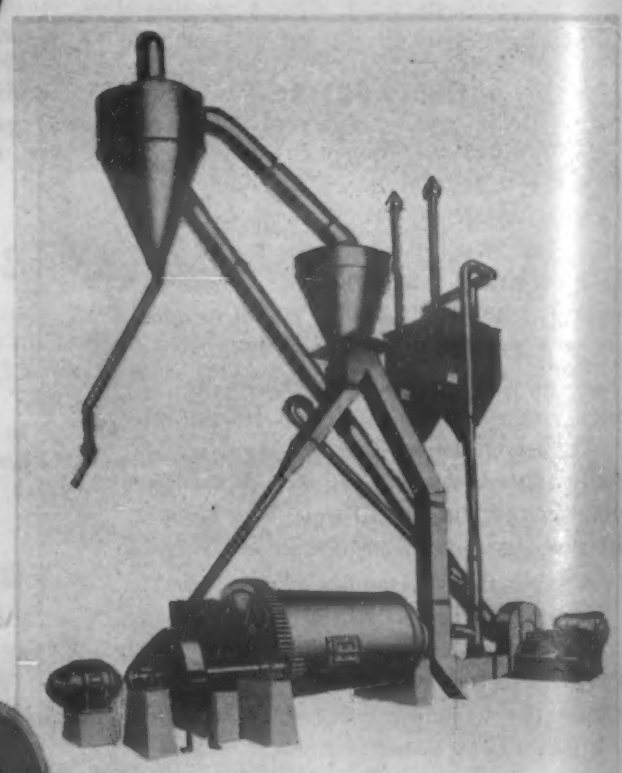

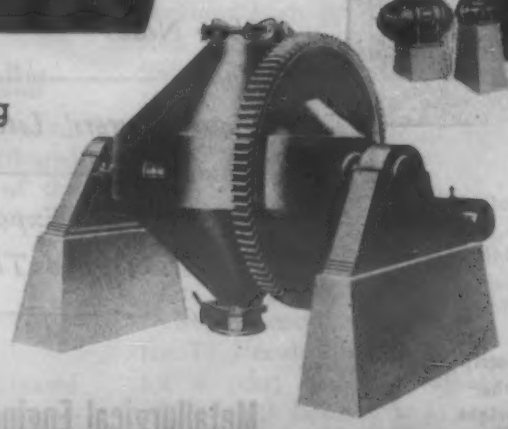

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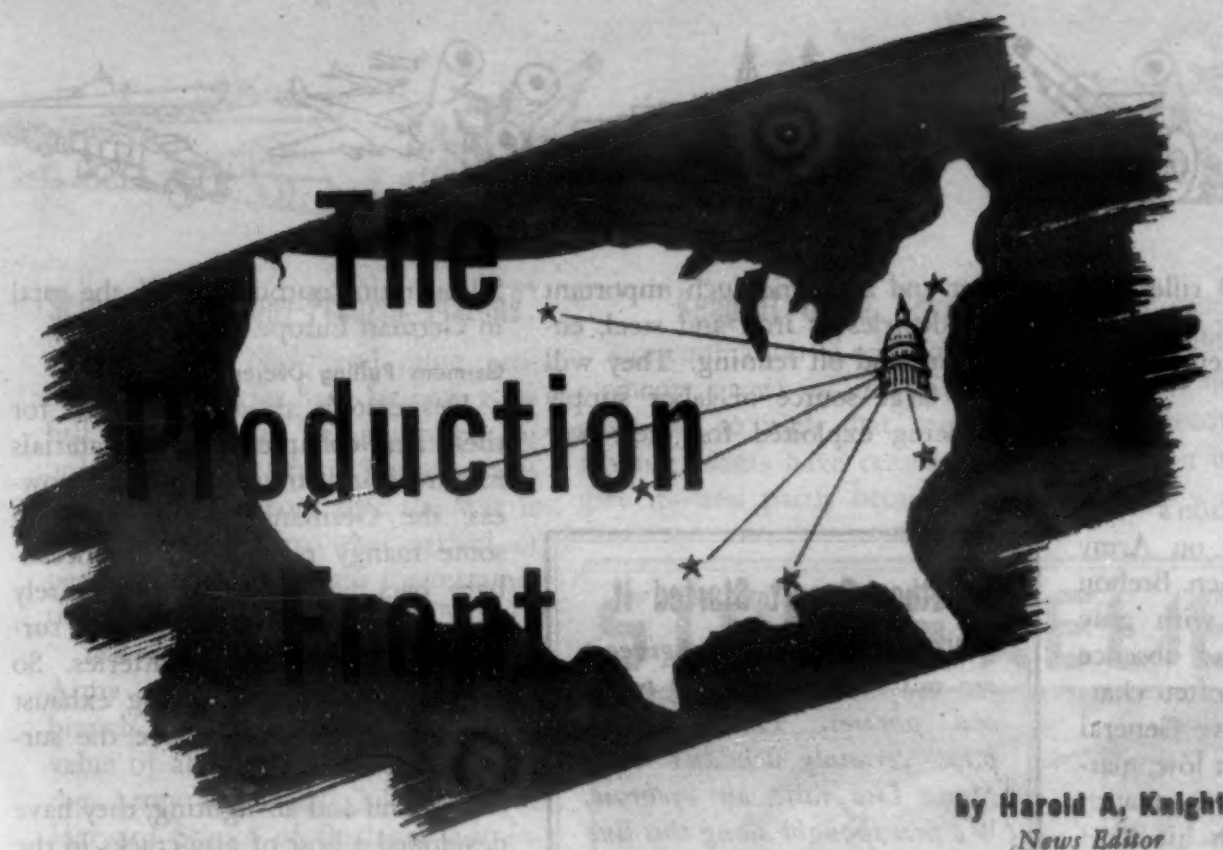


by Harold A. Knight
News Editor

We have spent $130,000,000,000 on war equipment. . . . Employment given to 15,500,000 idle persons. . . . 4,000,000 more women workers. . . . Per man output up 35%. . . . Aircraft plant productivity gains threefold. . . . Fighting fleet is three times that four years ago. . . . One artillery piece to every 46 men against 1,100 men in 1917.

For every 100 rifles, annual replacements are 60. . . . We are short in 320 critical items, with a dozen outstanding. . . . Germans turn to higher carbon steel. . . . Nazis are losing much raw material. . . . They develop equipment in Rube Goldberg class. . . . Shall we glamorize engineering terms? . . . Army Air Corps goes to school to learn terminating of contracts.

Many a gem of a war goods part must be scrapped. . . . A.A.F. has already disposed of 4,000 termination cases. . . . Our cartoonist's own version of "shrink fit." . . . Contamination of scrap intensifies with 4300 steel scrap a "problem child." . . . WPB recognizes value of spectrography. . . . We must further streamline foundries and forge shops. . . . More metal for civilians from "cradle to grave."

Labor Day Box Score, As of 1944

Not only has the War Production Board given us a host of facts about our production to date, in the style that is to our taste, but it has even furnished the above headline. Perhaps Donald M. Nelson and we are round pegs in square holes. Perhaps *we* should be going on that "exile" trip to China and Don be here at our cluttered desk, getting out this column.

Don has put oomph into his facts and figures in a way that would satisfy the Hearst newspapers. Here is Don, virtually speaking to *you*, reader, arching those delicate eyebrows and pointing at you his bull-dog pipe —as he often has done to us newsmen.

Since July, 1940, we have produced more than $130,000,000,000 worth of planes, tanks, guns, ships, ammunition and accouterments. At the same time, we were expanding, our armed forces to 9,500,000 fighting men. During these four years 15,500,000 persons, idle as of 1940, have been employed. Women workers have increased by over 4,000,000. More than 10,000,000 have been trained in public vocational training courses.

Output per war worker generally has increased 30 to 35% from December 1942 to April 1944. In West Coast airplane plants, output per worker has upped 514% in three years, while the average gain in that industry has been threefold. Mass production, better utilization of labor and better cooperation generally effected this.

The number of workers in the aeronautical industry plants reached its peak at the end of 1943 and leveled off the first part of 1944. From here on the number will probably decrease, due to increased efficiency.

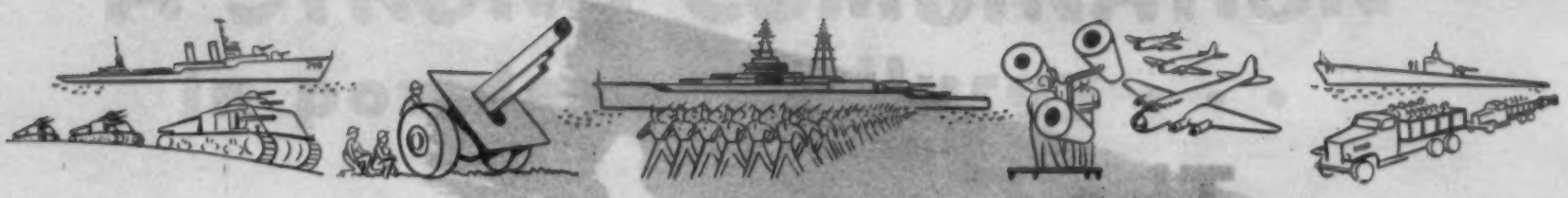
Battle Fleet Has Tripled

Our fighting fleet is three times as great as it was four years ago, with 1149 combatant ships this August. Our merchant fleet has over 3300 ships. Now shipyards are delivering one ship per day, and this year's new tonnage will be nearly 17,000,000 deadweight tons. So much for production.

Consumption is a horsepower of another color, so to speak. In one hour's firing, a 75-mm. field gun expends 7,250 lb. of copper, 3,000 lb. of zinc and 42,500 lb. of steel. In 1917, every 1,100 soldiers had one piece of artillery; today, every 46. To date, 42,000,000 measurement tons of Army cargo have been shipped overseas. More was shipped to North Africa alone than totals shipped by us in the first war.

If all the bombs produced for the Army were dropped on the nation's capital, more than 4,000 would fall in every block. In a fortnight in the Marshalls, the Navy expended 58,800,000 gal. of fuel oil and gasoline.

In the battle of Manila Bay in 1898, Dewey's fleet expended 73 tons of shells; at Tarawa the Navy shot 2,200 tons of shells, aircraft dropping 500 tons of bombs. For



every original lot of 100 rifles, annual replacements are 60; for every 100 machine guns, replacements are 85 yearly.

What We Still Most Lack

So much for Mr. Nelson's "box score." Leading authority on Army supplies is, of course, Lt.-Gen. Brehon B. Somervell, that man with gray hair, soldierly bearing and absence of extreme waistline that often characterizes the 50's. Let's have General Somervell talk to us in that low, matter-of-fact voice of his—a man with a sense of humor beneath his hard crust.

Though the Army is in fine shape as to supplies generally, it is short in about 320 critical items, with about a dozen items that merit special attention. Among these are thousands of miles of pipe, 80,000 heavy trucks, tires, ammunition of various types, tanks, aircraft equipment, Radar and radio equipment, construction equipment, tractors, artillery cranes, derricks, bulldozers and shovels.

Rate of fire for artillery has been more than doubled above estimates, continues General Somervell. Heavy artillery, rather than air power, broke deadlocks at Anzio, Cassino and in Normandy. Both new guns and replacement linings are needed.

Pity (?) the Poor Germans!

But, of course, Allied equipment is super-abundant compared with the German. Because of lack of alloying metals, Germans have been forced to go to higher carbon steel to achieve depth of hardening. This results in higher hardness and brittleness, and vulnerability to large projectiles. They add emergency extra plates or tank treads in a futile endeavor to combat U. S. firepower.

The mining of Baltic and North sea waters by Allied air forces is probably causing the loss to the Germans of 2,000,000 tons of Swedish iron ore, which is perhaps as serious as military losses in France and East Prussia.

When the Allies capture Polish areas still under German domination, our enemy will lose coal, iron, oil, timber and zinc, and such important war industries as iron and steel, engineering and oil refining. They will lose a large source of labor supply now being exploited for their war effort.

Weather Report Started It

We wonder if we engineers are not too drab in our terms and phrases. Thus, "50,000 p.s.i." certainly wouldn't make Mona Lisa raise an eyebrow. We first thought along this line on Aug. 17 when our newspaper predicted "pleasantly cool," after the longest, sweatingest heat wave we recall. That was the first glamor in a weather report since our boyhood in an Iowa village.

There, without daily newspaper, before the era of radio and when indoor plumbing was sketchy or non-existant, the high spot of the day was when the weather flag was hoisted opposite the drug store. A square white flag meant fair; a square black, rain. There were a lot of modifications—a polka dot flag meant spotty. And golly! What excitement when they raised a round red flag! Tornado!

Erudite Boston has plenty of stiff bosom terms: "Prepayment" cars for "Pay-As-You-Enter." The Washington intelligentsia have coined a few $64 words for use in Social Security Building.

But we engineers! How about "terrific tensile strength?" Or "truly shocking impact tests?" Or "tantalizing electrical conductivity?"

Germany will then be deprived of an area hitherto comparatively immune from Allied bombing, to which she has been transferring plants from the homeland. Pig iron capacity of Poland in 1938 was 900,000 tons; crude steel, 1,500,000 tons. Polish Silesian zinc output is 20% the total in German Europe.

Germans Pulling Decrepit Rabbits

Desperately trying to atone for their near-collapse in raw materials resources and inferior fighting prowess, the Germans are now pulling some mangy rabbits out of threadbare hats. Submarines now rarely dare show themselves above the surface, even to recharge batteries. So they have concocted a long exhaust pipe that elbows up above the surface.

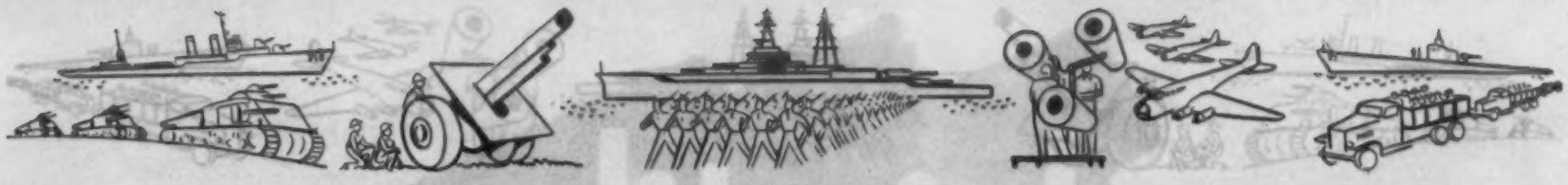
For land and air fighting, they have developed a host of gim-cracks in the class of pinwheels and Roman candles of an old-fashioned Fourth of July. These they employ against our airplanes—merely "scare" items —such devices as flying particles, trailing wire, bursting rockets and flying disks.

They have four models of jet-propelled aircraft. They are very fast, but apparently of very limited range and duration of flight. The Germans used against our shipping in the Bay of the Seine the same types of radio-controlled glider bombs they employed in the Mediterranean, with indifferent success.

Their many remote-control devices look good only on the drawing boards. There are several indications that the Germans may yet turn to chemical warfare. It is known for certainty that large quantities of gas masks have been manufactured in Germany.

Speaking of new weapons, we wondered why one of our new mobile weapons was called the "Weasel." We learn that it is because it moves stealthily and swiftly. A full-track-laying vehicle, the Weasel will remain on top of, and secure footing in, soft, porous substances where wheeled vehicles or conventional track-laying vehicles would bog down. It can climb a 45° incline and turn in a 12-ft. radius.

As to labor, foundry owners deplore publicity describing foundry employment as "hot, dirty and onerous." Women constitute 9.6% of the working forces in 74 foundries surveyed.



Scrap That Tiffany-Precise Piston?

The Army, Navy and other procurement agencies have by now gone full speed ahead in planning for orderly termination of war contracts —not on the theory that the war is nearly over—but so that arrival of peace will not find plans for termination "too little and too late."

We sat in with officers of the Army Air Forces, the important branch that handles 30% in dollar value of all Army war contracts. At the Army Industrial College at the Harvard School of Business Administration and at the Material Command School at Vandalia, Ohio, contracting officers, negotiators and property disposal officers are being trained in the orderly termination of war contracts.

By Jan. 1, the A.A.F. goal is 4,200 officers and civilians well trained to circulate among the manufacturing plants. Legal officers are being trained at Ann Arbor and auditors at Dayton, Ohio.

The A.A.F. has to date disposed of about 4,000 termination cases, for a total value of cancelled items of $2,000,000,000. A backlog of 2,000 cases, involving $4,000,000,000, in cancelled items remains unsettled.

The touchstone of contract terminations settlements is that they shall be negotiated settlements—not long, drawn-out jousts between accountants and lawyers over technical points. With some of the leading contractors, claims will usually be allowed to the extent of 95 to 100%, though the present average is considerably lower.

Though thousands of aircraft items, such as fractional horsepower motors, can be used in their present form in peace items such as refrigerators, vacuum cleaners, etc., a pathetically large number of expensive items must go to the junk pile.

Take the piston of a Rolls Royce engine—a beautiful thing to behold, tailored to thousandths of an inch! But it looks now as though it will have only junk value. It will be best not to dawdle over such items. Scrap 'em and get it over with.

Keep It Clean, Boys!

Contamination of scrap by alloying elements grows in intensity. Labor costs are so high that some scrap-making plants have ceased to segregate it—and partly because when it is segregated they get less for it than for carbon scrap. Hence, there is the temptation to let it mix with the carbon and get the higher prices.

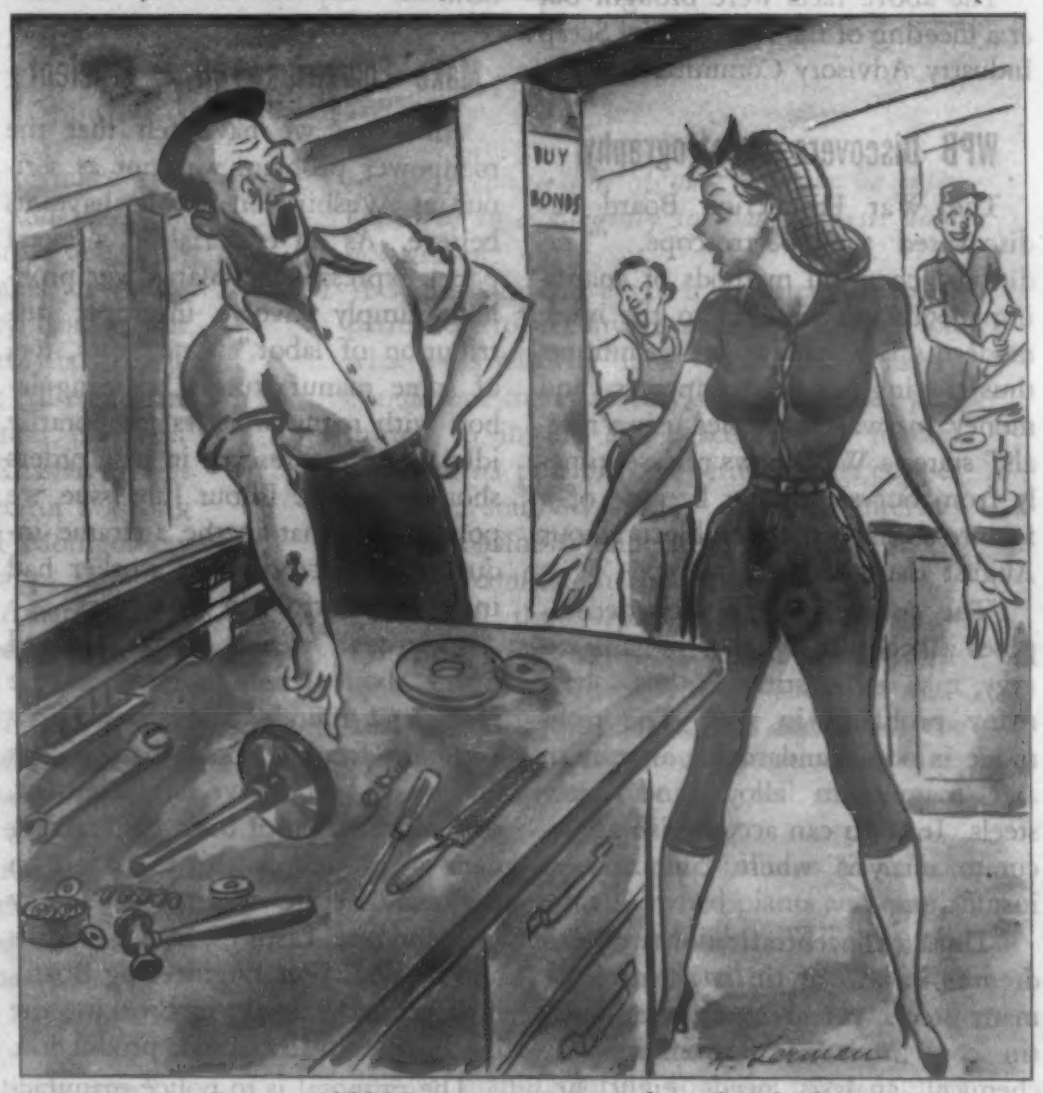
Heats of 4100 steel with as much as 0.50% Ni are common, though this steel should have no nickel, H. J. French, Steel Div., WPB, stated recently. Aircraft steels in the 3300 series often contain double the residual molybdenum that is standard practice.

In addition to the problem of contamination, there is the matter of conservation of virgin alloys. Fifty per cent of the nickel, 40% of the molybdenum and 25% of the chromium needed for steel in munitions are recovered from scrap. Any diminution in the recovery of alloys from scrap would add to the load on virgin alloys, the supply of some of which are threatened by manpower shortages.

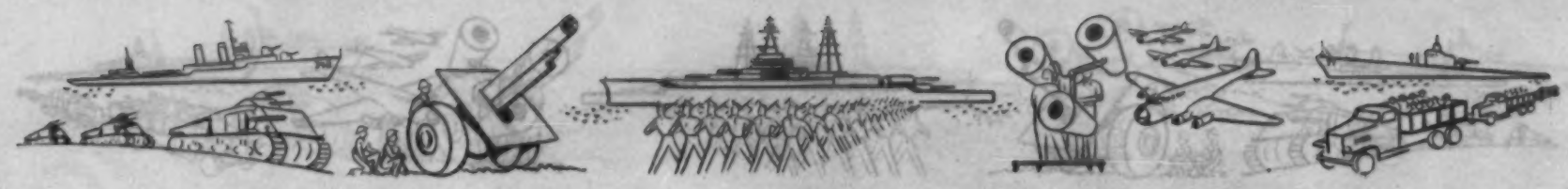
Some 75,000 tons of alloy scrap are being dissipated monthly by mixing with carbon scrap. The principal difficulty involves 4300 steel scrap and other triple alloy grades that are difficult to move and are mixed with carbon.

Though only 6% of alloy steel production is of the 4300 series, the problem of this 4300 scrap is far out of proportion to that 6%. Some of the excess 4300 scrap could be used

STRESS RELIEF By Gilbert



But you TOLD me you wanted a shrink fit!



in the production of three-way alloy steels, if it were not necessary to meet the 50% scrap charge requirement laid down by WPB.

Improper segregation of battlefield scrap has also caused trouble, and the situation gets worse. Moreover, if residuals in home scrap get too high, mills will have trouble in meeting specifications.

The above facts were brought out at a meeting of the Iron & Steel Scrap Industry Advisory Committee, WPB.

WPB Discovers Spectrography

The War Production Board has discovered the spectroscope. "Traditional chemical methods of analyzing metals are yielding to the more modern spectrographic technique, thus saving time, manpower and money for war industries using metals," states a WPB news release, timely from our standpoint because of a feature article on the subject in our August issue.

"The spectroscope, which decomposes a beam of light, or radiant energy, into its constituents, has solved many problems in war. The technique is now standard for aluminum and magnesium alloys and many steels. It often can accomplish an accurate analysis where chemistry is insufficient.

"Thus, a concentration of two hundredths of 1% of tin is harmful for many steels, yet in much scrap such tin content is not uncommon. A chemical analysis needs eight hr., while a spectrographic analysis needs under 10 min. The latter can be made while the furnace is waiting.

"Take magnesium alloys. A calcium content of one-tenth of 1% destroys usefulness of many such alloys. Because of the chemical similarity of calcium and magnesium, chemistry will not detect so little calcium, but the spectrograph will.

Reasons for the inadequancy of chemistry are: It is time-consuming and is profligate in manpower; since much new scrap must be used constantly, routine analyses must be made, for which chemistry is very laborious or not feasible; some impurities occur in such small amounts that they cannot be conveniently detected by chemistry.

"States Dr. G. H. Dieke, physics professor, Johns Hopkins University, 'Spectrographic methods can be systematized to be used by relatively unskilled workers. Such procedure will save persons with specialized training who are almost unobtainable now.'"

Make Foundries 100% Efficient

All along we have felt that the manpower problem was not as serious as Washington would have us believe. As an editorial in a metal paper expressed it, "manpower problems simply involve improper distribution of labor." One hears, too, of some manufacturers hoarding labor, with many workers temporarily idle, to have a reserve in case orders should increase. In our July issue, we pointed out that in the airframe industry, productivity per worker had increased fourfold in four years.

In recent weeks one has heard much about labor shortage in the forge and foundry industries. Now we hear from a spokesman of the Society of Automotive Engineers, Inc. that compilation of basic engineering data on process control procedure in the manufacture of malleable, gray iron and steel castings, begun months ago by SAE War Engineering Board, now promises to aid in breaking the bottleneck to increased production.

The proposal is to police manufacturing processes and reduce excessive rejections and large-scale scrap losses that make the greatest barrier to increased output. Urging close cooperation, from design to completion of castings, the recommendations suggest analysis of every detail and phase of manufacture, preparation of plant production manuals and rigid adherence to specifications thereafter.

Proper inspection and selection of raw materials, segregation of scrap, proper operation of furnaces, cupolas and other equipment, and repeated quality control checks are advised.

The War Manpower Commission recently appealed for 8,000 to 20,000 workers to take 90-day jobs in forges and foundries to step up by 60% production of forgings and castings for heavy duty military trucks and tanks, and to increase by 25 to 30% the output of major forging and ferrous casting plants for the rest of 1944.

From Cradle to Grave

At a recent meeting of toy manufacturers, a spokesman for the Government promised a reasonable amount of metal for toy manufacture.

Under date of August 16 is the following notice from WPB: "The projected production of metal caskets from frozen inventories, as a first step toward re-establishing normal output in the industry, was discussed at a recent meeting of the Wood Casket Industry Advisory Committee, WPB reports.

"WPB estimates that about 30,000 metal units could be made from frozen inventories in the possession of manufacturers. Metal casket manufacture has been prohibited since 1942, in favor of wood. Many manufacturers normally make both metal and wooden types."

As to Civilian Manufacture

We are inclined to side with Donald M. Nelson towards liberality in resuming somewhat wholeheartedly the manufacture of civilian goods. We have already demonstrated our miracle of production, and feel we can well take on more peace goods. Experience teaches us that the Army and Navy have the foresight and hoarding instincts of a squirrel, and have plenty of packaged wallop stored up.

Operations in France doubtless consumed less munitions than had been expected. In the Pacific, we are not performing island "hopping," but rather "skipping," letting many Japs "rot on the vine," thus saving munitions. After the first World War, it took several years to dispose of surplus materials, so vast were they.

Of course, we are only laymen, and we may merely have "laid an egg" in the nest of sound strategy.

Are We Ready?

Much has happened in recent weeks to make ever more urgent the speedy consideration and planning by government, industry, single companies and individual engineers of the specific programs and steps to be taken in transferring this country from a war economy to a peacetime structure. As this is written, the Germans are losing Paris, two great Allied armies approach a junction near the Reich border, the Axis' Balkan appendage is collapsing, and Russian troops are poised on the East Prussian frontier for a killing blow. Usually noncommittal, General Montgomery declares the end is near. When the happy day does come, approximately 30 to 35% of American war industry's output will no longer be needed for military purposes.

If the day comes suddenly, as we all hope it will, will we be ready to fill that gap in war output with civilian production and thus avoid a chaotic interlude between total war and total peace? If well-laid plans are not ready for systematic application, the war's end may inject considerable misery into the general joy and, in a larger sense, any consequent internal upheaval and economic depression may cancel the victory so painfully won by American fighting men, workers and industry.

The problem of reconversion has many subdivisions, all interrelated in complex fashion. Let us examine some of the questions that present themselves:

(1) What policy and procedure should be adopted for terminating war contracts that will be (a) financially fair to the plants concerned, (b) economically sound from the standpoint of government and the taxpayers, and (c) "cushioned" in its impact on production schedules and general employment?

(2) Will individual plants be ready with their new-product designs at the moment that reconversion becomes possible? Will they be able to obtain the necessary tools and machines to start production? Will the materials and manpower they need be obtainable? *In short, will the essential elements for the speedy reconversion of our factories be integrated as to availability so that paralysis does not occur?*

(3) If some plants in a given industry are to be permitted to reconvert ahead of others, on what basis will the "lucky" plants be selected? Should one material (say, aluminum) be permitted to invade the peace-product market ahead of its possible competitors (*e.g.* copper alloys or stainless steel)? Are the interests of "big business" and "little business" necessarily in conflict in this respect?

(4) How will the surplus war materials—raw materials, goods-in-process and finished equipment—be disposed of without jamming markets, collapsing price structures and killing the opportunity for prosperous operation of plants hoping to manufacture and sell these same materials?

(5) What will happen to the billions of dollars worth of government-owned plants and equipment that may soon be idle? Will they be bought by or, indeed, offered to their present operators or industry in general—and if so, at what prices? Will the existence of this colossal manufacturing potential put a damper on the market for new machines and equipment? Does the government intend to remain as an important manufacturer of many products, in competition with private industry? Should plans be made now to sell this equipment (and the materials covered in 4, above) at bargain prices to foreign nations for reconstruction or industrialization?

(6) The reconverting plants will be expected ultimately to absorb an employment load swollen simultaneously by returning veterans, and by war workers discharged because of the 30 to 35% drop in war output previously mentioned. General Hershey believes that 1 or 2 million men may be released by the armed

(Continued on page 615)

NEW

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Ryerson has always exercised close control over alloy steel quality and for several years has furnished the chemical analysis and heat treatment response data with each alloy shipment. Now, this service has been extended under the Certified Steel Plan to give new additional information . . . much more helpful than before.

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Whether you order a single bar or many tons, you can be sure Ryerson will furnish Reports covering every alloy shipped. Both steel and Reports are delivered together on local shipments. When shipment is made by other than Ryerson motor service, the Reports are sent by first class mail and addressed to the heat treating department.

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services at the time of Germany's capitulation. Do we have a systematic and sensible program for getting these boys home *without delay,* assisting them during the transition period and assuring the speedy reemployment by industry of most of them? Quite aside from the primary consideration of the humanities of the situation, their continued idleness would throw an economic blight on the entire post-war-prosperity program from which it might recover only with difficulty, if ever.

These are only the obvious, more simple aspects of the problem. But merely to list them is to reveal boldly the currently sad state of our preparation for peace. In a few weeks or months we may have a small sample of the peace-problem as it relates to domestic industry. Let us hope that some plans will soon emerge whereby the interim between Germany's and Japan's surrender may be fraught with a minimum of home-front confusion and trouble and may even be utilized to develop policy, methods and preliminary steps for the tremendous demobilization and reconversion job we must do when *all* the shooting stops.

—F.P.P.

The Stainless Steels

Some very interesting developments have been taking place in the production of the stainless steels—trends which are quite significant. This refers to the data for 1943, just recently made public by the American Iron and Steel Institute. They reflect the profound influence of the war effort on this industry.

The 1943 total for these steels as a class—457,448 net tons—was a new record, despite the restrictions of the use, for some purposes at least, of nickel and chromium. And the increase over 1942 was substantial—116,668 tons or 34.2 per cent.

But this is not the most surprising fact in the 1943 data. The increase in the demand for the 12 to 14 per cent Cr type was the largest on record—the total was 98,997 tons or 57.8 per cent over the 1942 total, a significant expansion, not approached heretofore. In a similar manner, the output of the type classified as "all other high Cr or Cr-Ni alloys" expanded last year markedly over 1942—the total was 79,779 tons or an increase of 51.3 per cent over the 1942 total of 52,562 tons.

In only one type of these steels was there a decrease recorded last year—less of the 16 to 18 per cent Cr grade of steel was made in 1943. The 1943 total was only 21,662 tons or 6.67 per cent less than the 1942 total.

These rather surprising developments are highly interesting as showing the broad extent to which these corrosion and heat-resisting steels are being used in the war effort. It would be a satisfaction to know in just what applications the various types are used but some of this is probably a military secret. It would also be gratifying if the data on these steels were available thus far for 1944. It is highly probable that the same trends revealed by the 1943 data still prevail this year.

The stainless steels have been and are a major factor in the winning of the war. It is reasonable to expect that there will be a greater use of these in the post-war era than in the pre-war. The future for these steels is indeed bright.

—E.F.C.

"It Can't Be Done"

The past three or four years have been embarrassing for many of the "It-Can't-Be-Done" boys. Their number has always been legion. Way back they proved by aerodynamic laws of those days that man could not fly in heavier-than-air craft. According to many of them the bumble bee does not fly in theory because he has too much body for limited wing span.

Certain steel men said a few years back that automobile bodies and fenders could not be stamped and drawn with satisfactory strength, thinness and uniformity; that the steel cartridge case could never be a practicality; that radio at best would be a toy for amateurs to play with.

Speaking of bumble bees and insects generally, the "doodlebug" that now pesters Southern England was laughed off many drawing boards. Rockets were regarded as a somewhat humorous weapon of the war of 1812 and lived in our memory only because of the "Star Spangled Banner" and its "rocket's red glare" reference. The modern ballistics experts have evidently overlooked the inherent theory of power in a missile being driven forward by nascent power at the very moment of striking the target.

We feel that there is much to look forward to in the way of startling improvements in peace time techniques. The war has made us dissatisfied with old methods and routines. We will have more leisure and concentration in peace to do even more startling engineering things.

For instance, when grandma made that famous apple pie, she did not heat it in the oven, say to 300 F, remove it and quench it at the kitchen sink, then reheat in the oven to 250 F, etc.

Will not some day much of our heat treating and auxiliary operations be eliminated, or at least be done simultaneously with the forming operation? Haven't some of them already been skipped in the modern Martempering or Austempering hot-quench processes? Will we not have rolling mills that (1) either do not produce strains in the first place, or (2) remove strains a split second after they have been caused by equipment integral with the rolling mill? Perhaps we'll gradually eliminate the ingot stage in metal-production, taking our present continuous casting methods as a start. Or, are we too much of an "It-*Can*-Be-Done" fellow?

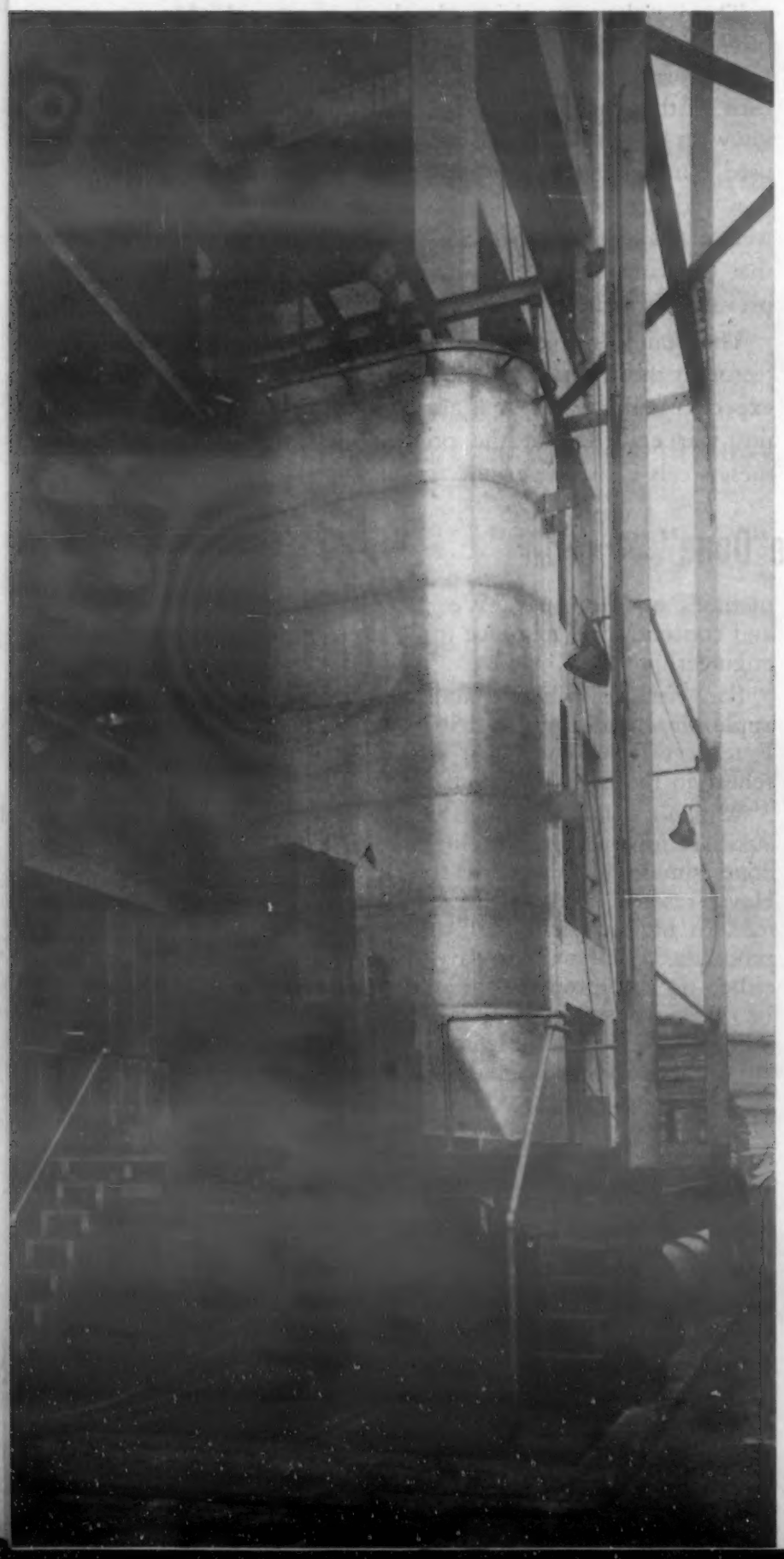
There will at least be developments equally as striking as the fantasia outlined above and it is perhaps best not to laugh too loud at such proposals—for some other person may laugh last.

—H.A.K.

(Continued on page 650)

Stainless Steel Stampings for Ship Parts

by **W. J. MEINAL** *President, Heintz Mfg. Co., Philadelphia*



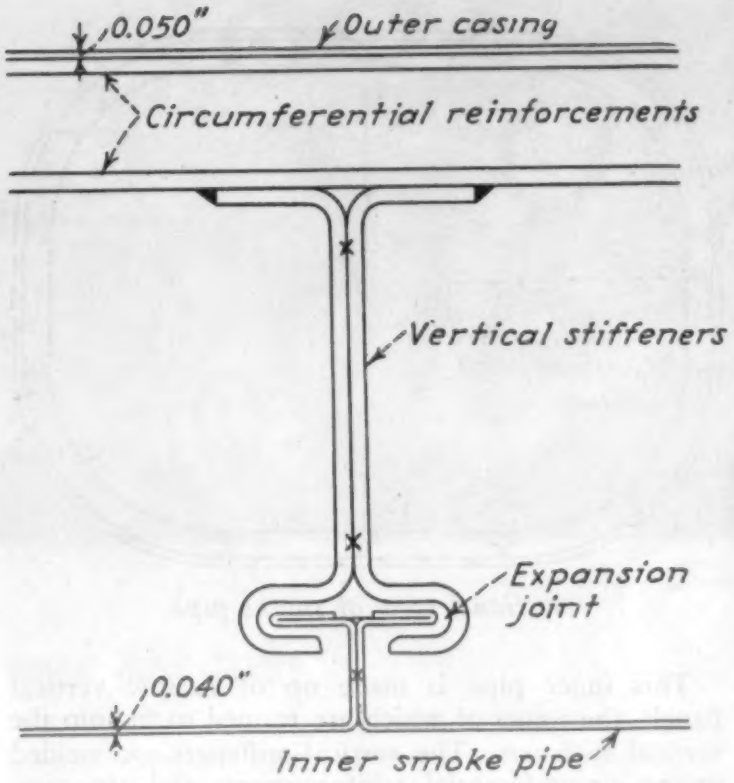
This article describes the application of a modern structural and corrosion resisting material—stainless steel—and a modern metal-form—stampings—to the design and construction of important ship components with outstanding production-speed, cost and engineering advantages. —*The Editors*

THE PROBLEMS OF WAR PRODUCTION with the attending demand for large volume output complicated by shortages of manpower, machine tools, and critical materials presented a challenge to industry which has been met and is being solved by American industry—through the use of advanced methods of production and improved quality of materials. One of the outstanding examples of new approaches to old problems and the solution of entirely new problems is in the field of pressed metal, where a noteworthy contribution has been made to shipbuilding and other war materiel.

With quantity and quality equally important, design engineers and stamping manufacturers have made many conversions to stampings of many parts originally machined from castings, forgings or bar stock. Stampers have found ways and means to do things formerly thought impossible by the use of sheet or strip metal processed under dies. They have ventured completely new techniques for stamping and fabricating parts and in the assembling of many individual pieces into a single item.

Intelligently translated into production of peace-time goods, these developments will create new horizons and new markets for stampings. However, it is important to be fully aware of the necessity for continued resourcefulness and engineering development work in individual stamping plants and in the industry as a whole. With the same type of creative thinking that has been applied to war materiel, almost unlimited achievements will be possible in the production of materials for civilian use in the post-war period. Conservation of materials and lowered manufacturing costs will continue to play an important role in peace-time production, and these factors will necessitate continued planning by the stamping industry and by design engineers.

The stainless steel outer shell for the smoke pipe. This is built up of pressed panels spotwelded together.



How inner and outer pipes are joined to permit differential expansion.

New Techniques and Tools

War-time research, engineering and production have specifically broadened the knowledge as to the use of various methods for producing stampings, and for joining two stampings of the same or different metals. It has also widened the use of various new ferrous alloys, and the lighter metals, and emphasized the value of better tooling. For many years, stampers were neither encouraged nor compelled to extend themselves in the development of new methods.

Another great lesson learned by designers and engineers struggling to solve matériel problems has been this: That the best dies and tools possible are essential factors in acquiring the best production results at low cost per unit. Stampers in the past have been handicapped by the desire of customers for a product at the lowest possible tool cost. Low tool cost prohibits stampers from developing either new and better tools, or a new approach to the problem. Volume, quality and speed generally justify a liberal expenditure for dies and special fixtures and result in an improved product at a reduced production cost. It should be easier in the future to secure the approval of the customer for more expensive and better tools on the basis of industry accomplishments in meeting war demands.

The value of better tools is illustrated by a job where the tool cost was increased from $600.00 to $15,000.00. This investment in tools reduced the production cost of the item from $7.20 each to $1.24 each on an order for 200,000 pieces, a saving of $1,192,000.00 or 80 times the tool investment cost. In this instance, the problem was approached from the standpoint of a stamping engineer with a volume production background.

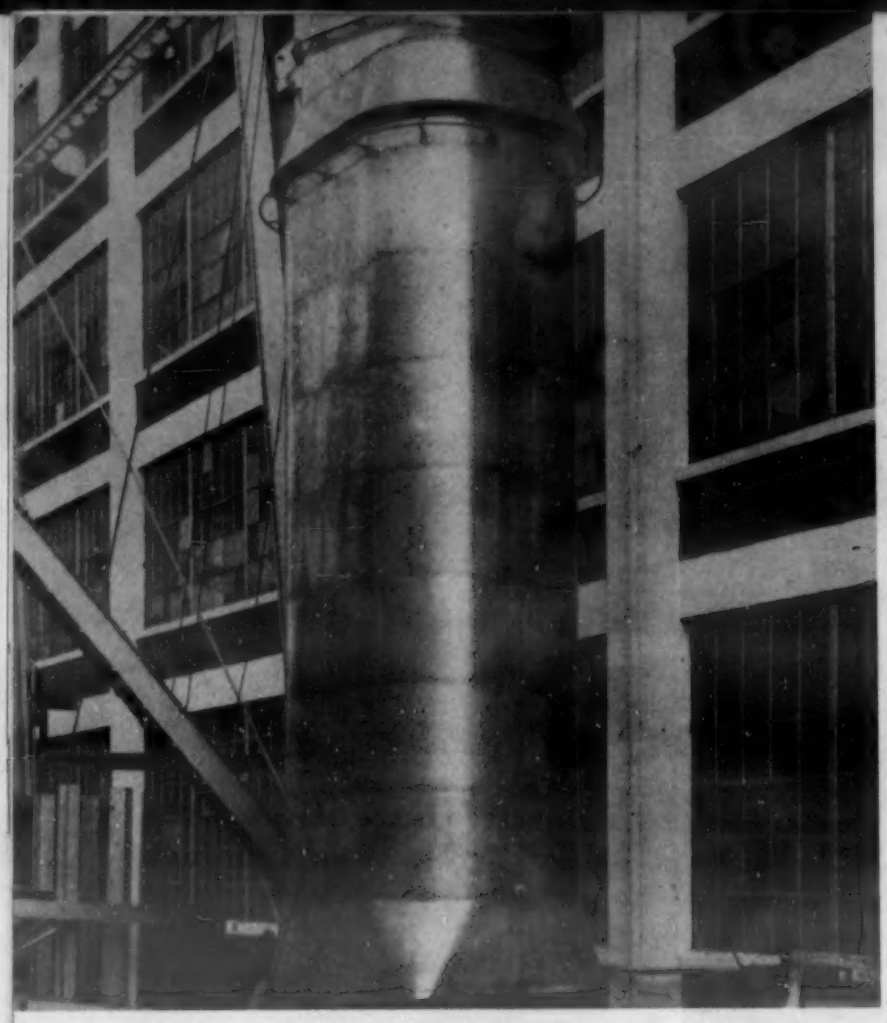
A field in which pressed metal has not heretofore been widely used is that of marine equipment. The

The outer section is lowered over the inner shell for assembly. Vertical stiffeners, shown in this view, are welded to narrow vertical panels to form the inner section. The outer casing is fastened to the inner by T-slots in the vertical ribs engaging flanges on the inner pipe, permitting longitudinal expansion.

shipbuilding industry has been largely concerned with custom built work, and it had neglected to make use of high-production techniques, even for those parts which were obviously suited to such techniques. With the wartime boom in shipbuilding mass production became its keynote, and ships today have a number of standardized items, large and small, in their structure made by press methods.

A Smokestack Redesigned

An interesting example of the skill and ingenuity of stamping engineers is the redesigned naval smoke pipe. These smoke pipes usually consist of an outer



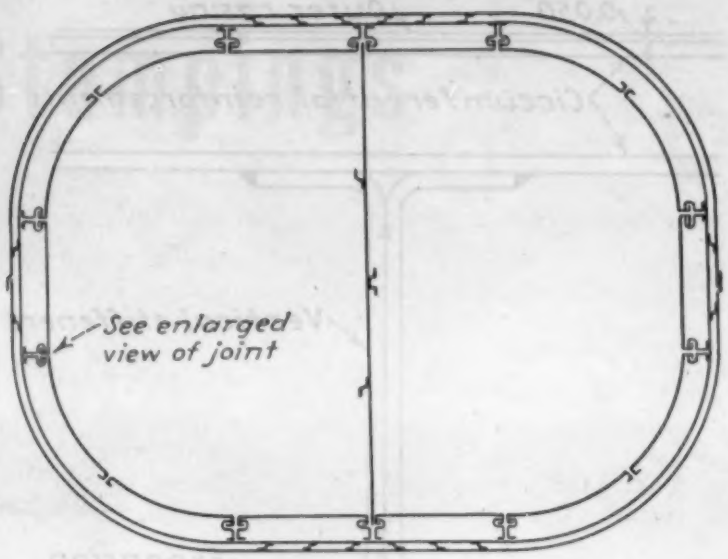
Smoke pipe after assembly. The hood and ladders are bolted in place, making disassembly a simple matter.

and inner pipe with an air space between. Before the war, the conventional method of building smoke pipes was to use the inner pipe as the strength member and the outer casing as the cover.

On account of their elevation on vessels, lightness of weight is an essential factor. Strength too must be maintained. They must also resist corrosion and must be so designed as to reduce to a minimum over-haul time. After extensive experiments it was found that molybdenum-bearing stainless steel ("18-8-SMO") gave the greatest resistance to corrosion for this particular use. This metal was, therefore, adopted for the inner pipe. The outer casing was constructed of ordinary "18-8" stainless steel.

In the smoke pipe redesign worked out by men familiar with pressed metal techniques, the inner pipe is made the strength member for only 3 feet above its foundation. At that point the stresses are transferred through intercostals to the outer casing which then becomes the strength member. The metal used in the outer casing is 0.050 in. thick.

The inner casing above the transfer point is only 0.040 in. thick, and is built in several sections, reinforced with angles which permit the sections to be bolted together. This construction enables the removal of either the top section or of the whole inner pipe without disturbing the rest of the installation. It is necessary to provide for longitudinal expansion of the inner pipe in relation to the outer casing. This is accomplished by means of vertical ribs rigidly attached to the lower intercostals, and extending to the top of the pipe. These ribs are welded at intervals to the circumferential reinforcements of the outer casing. The T-slot in these ribs engages corresponding flanges formed on the thin inner pipe.



Sectional view of smoke pipe.

This inner pipe is made up of narrow vertical panels, the joints of which are formed to fit into the vertical stiffeners. The vertical stiffeners are welded to the circumferential reinforcements and are composed of two formed pieces of metal, spot welded together. The outer casing of stainless steel is made up of panels, spot welded together on a special power-driven machine which rotates the casing, and positions the welding tools so that they always act in a direction normal to the surface to be welded.

The average weight varies between 5,000 and 6,000 lb., and vary from 22 ft. to 25 ft. high and 6 ft. 4 in. to 8 ft. 4 in. in cross section. Due to their size and weight the assembly is performed out-of-doors and alongside the manufacturing building. After the inner and outer pipe have been assembled independently, the outer casing is telescoped over the inner pipe. The hood and ladders are then bolted in place, which completes the assembly ready for shipping.

This redesigned smoke pipe not only met all naval requirements, but speeded up production time. Through the use of stampings and mass production techniques, the time required to complete a stack, including inner pipe, outer casing, hood, ladders, platforms, etc. was reduced to 3½ days.

Subassembly of end cross-member and hatch cover. Measuring 19 in. by 120 in., this is the largest member in the cover. The main upright consists of three stampings welded together.

The skeleton hatch cover before the metal covering is placed.

Hangar Hatch Covers

When the Navy Department decided to build hangar space on some of the cruisers, below deck instead of above, an opening in the deck sufficiently large to permit passage of the planes in and out was required. These openings were approximately 17 ft. by 39 ft. In order to close the opening a cover made from assembled and welded stainless steel stampings was designed.

This cover rested on a coaming and was provided with a rubber gasket or sealing strip to make the hangar space air and water tight. The cover proper is made entirely of 18-8 stainless steel, as is also part of the mechanism. The cross ribs are of hollow construction and about 18 in. in height. (See photographs sub-assembly of end cross member and skeleton hatch before cover is applied.) In the production of these covers, 3000 stampings are required. In the sub-assembly of the end cross member alone, 45 stampings are assembled by arc and spot welding.

The problems involved in designing a cover of this size were numerous. Among the important ones was that the cover when dogged down should reinforce the large opening cut through the deck structure. Another was due to the fact that the cover is located in the vicinity of one of the gun turrets. Although normally, the cover would have to withstand 1½ lb. pressure per sq. in., it was required to withstand 10 lb. per sq. in. on the end nearest the gun and 7½ lb. on the opposite end. Furthermore, the shock of the gun blast would also damage the rubber gasket, if it were not properly allowed for. The force of 10 lb. per sq. in. on the cover produced a force of 37,000 lb. on the lower roller of each dog. The complete operation of the cover is controlled by electric interlocks so as to provide the proper sequence of operations.

To open the hatch it is first raised clear of the opening by a hand operated mechanism. It is then moved by electric motor along runways built into the deck. The time required to undo the cover and remove it 40 ft. along the deck to provide a clear opening is 75 seconds. The same time is required to close the cover and dog it down tight.

Assembled hatch cover, ready for shipping.

The total weight of the cover and its above deck mechanism is about 16,000 lb. Fifty cruisers have been equipped with covers of this type and 25 more are now under construction.

Other Shipboard Stampings

Switchboxes for marine service are made of pressed metal, with the ears welded onto the formed piece. Lead-in pipes are silver brazed in place. As these pipes must be watertight, the silver brazing is quicker and cheaper than welding.

Bulkhead doors and frames are also made as standardized metal pressings. When the present boom in shipbuilding has subsided it is safe to predict that many of these mass production items and techniques will remain in the industry.

Post-war planning presents many complex questions which can best be solved by the combined thinking and cooperative planning of the industry as a whole. Willingness to adopt new methods, creative imagination, more intensive research, engineering skill and good tools, will produce results in the post-war period as significant as those achieved in the production of war matériel.

Fig. 1. A standard test bar casting.

Nickel Bronze Castings

by **ELY PORTMAN** *113 Lexington St. Newport, R. I.*

The story of substitutions has not yet ended. Early in 1943 Mr. Portman presented to the readers of M&A the foundry practice and engineering properties of silicon bronze castings that could satisfactorily be substituted for high-tin gunmetal bronze. Subsequently silicon bronze has fallen from favor (chiefly for reasons of copper supply), but Mr. Portman and his associates developed a production practice for relatively hard-to-handle nickel bronze castings that permits their economical production, with properties well within specification limits. Details are presented in this exceptionally well illustrated article. The author is associate metallurgist at a large and well-known Eastern ordnance plant. —The Editors

IT HAS BEEN WISELY STATED that the sign of a well run foundry is its ability, in critical periods, to adopt a substitute for a substitute alloy without holding up production.

At the ordnance factory with which the writer is associated, the pre-war alloy that best suited its casting requirements was an 86-10-3-1 copper-tin-zinc-nickel alloy. Pre-alloyed ingots were used on about 95% of the castings made; for the remaining 5%, virgin metals were compounded in the foundry. Excellent results were obtained with this bronze for castings required to be pressure-tight.

In 1941, experimentation was started on silicon bronze[1] as a possible substitute. Data were obtained

on the changes in gating, risering, pattern dimensions, and melting practice that would be necessary should a change-over be desirable. Early in 1942, the tin situation became critical, and utilization of a tinless bronze became imperative. Substitution of silicon bronze was successful because of the experimental work completed before Pearl Harbor.

In the Fall of 1943 virgin copper became a critical metal, and it was rumored that silicon bronze would be outlawed because too much virgin copper was consumed in its manufacture; and also because silicon bronze scrap was "poison" to all other non-ferrous metals, presenting almost insurmountable problems to the refiner. It was felt that it was time to seek a substitute for the substitute.

Possible Substitute Alloys

In trying new alloys, the following were important considerations:

(1) Structural strength (40,000 p.s.i. tensile strength minimum).
(2) Soundness under hydraulic and air pressure.
(3) Changes in foundry practice.
(4) Utilization of secondary metals.

Two alloys with the following nominal compositions were tested: (1) Cu 85, Sn 5, Pb 5, Zn 5%; (2) Cu 87, Sn 4, Ni 4, Zn 4, Pb 1%. The first is the well known ounce metal; the second, a commercial alloy which we will call "Nickel Bronze." For experimental purposes, virgin metals were used to make ingots of the stated compositions.

The nickel bronze had somewhat greater fluidity. Both showed good surface appearance and microstructure. Machinability of both alloys was good. The physical properties of test bars of the two alloys made of virgin metals appear in Table 1.

Table 1.—Physical properties of test bars made of virgin metals.

	Ounce Metal	*Nickel Bronze*
Tensile strength	31,500-32,500 p.s.i.	42,000-43,500 p.s.i.
Yield strength	14,000-16,000 p.s.i.	18,000-19,000 p.s.i.
Elong. in 2 in.	22-24%	26-30%
BHN (500 kg. load)	48-52	52-56
Izod impact	8.0-11.0 ft.-lb.	11.0-14.0 ft.-lb.
Specific gravity	8.58	8.61

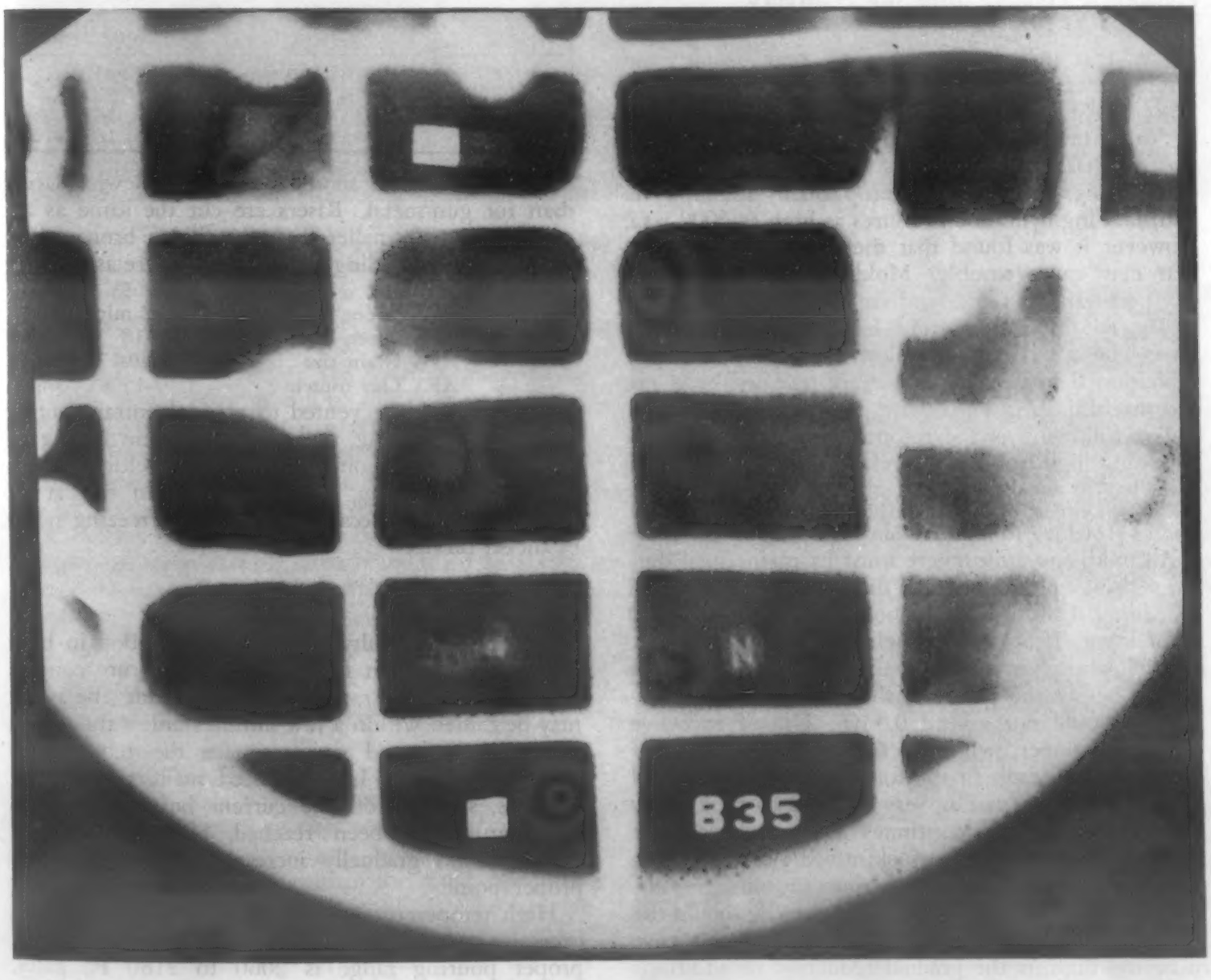


Fig. 2. Radiograph of an extremely porous casting.

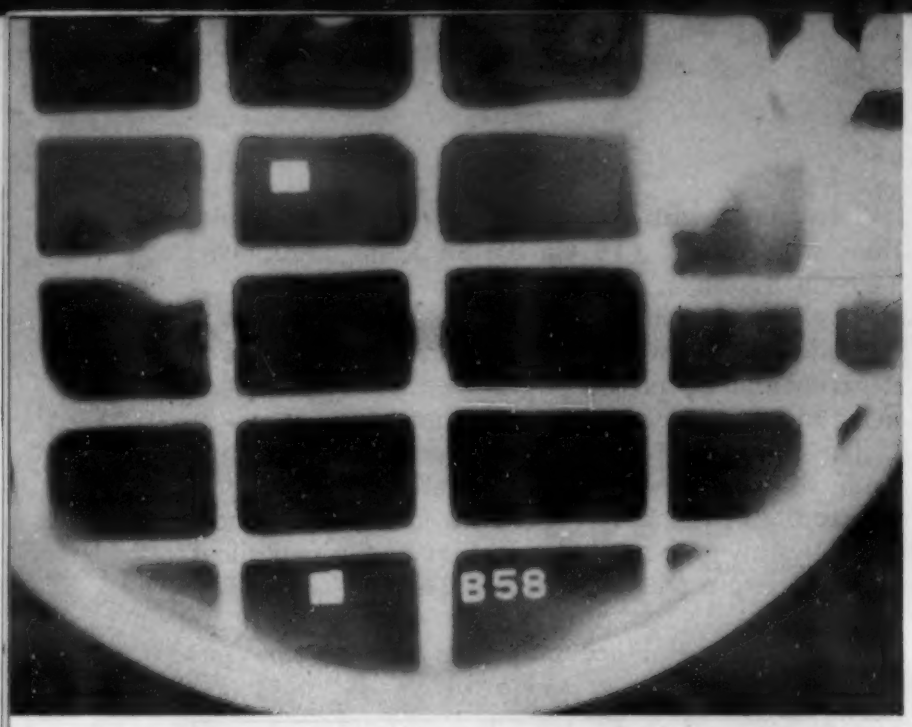


Fig. 3. Radiograph of the same type of casting as in Fig. 2, after adjustment of melting temperature and mold conditions.

Ounce metal was ruled out as a possible substitute because of its lower physical properties. Nickel bronze had very good prospects and it was decided to investigate this alloy more thoroughly.

Production Practice With Nickel Bronze

A smelter was found with a large supply of scrap metals that included nickel-silver, gear bronze, and gilding metal from which the nickel bronze could be obtained with the proper analysis.

A trial order of ingots compounded of scrap metal was purchased and pilot lots of castings were made. The castings proved to be exceptionally sound, some withstanding hydraulic pressures as high as 4000 p.s.i. However it was found that there are several factors that may cause trouble. Molds rammed too hard, low permeability sand, hard cores, and poorly vented molds, are all contributing factors in porous castings. The defects, mainly blowholes, are not usually visible on the cast surface, but are revealed by X-ray and machining.

The following is the recommended melting practice using high frequency coreless induction furnaces:

(1) Do not use charcoal on melt.
(2) Do not cover the crucible.
(3) Melting temperature must not exceed 2230 F.

An oxidizing atmosphere must be maintained during melting. Deoxidation of the melt is accomplished by adding 1 lb. of 10% phosphor copper per 100 lb. of ingot. If a 100% remelt charge is used, ¼ lb. of 10% phosphor copper is added to the melt about 15 sec. before the power is shut off. Residual phosphorus should not exceed 0.03%. Use of excessive phosphor copper, while increasing the fluidity of the melt, will result in the formation of a very fluid gray colored slag that is very difficult to remove by skimming. The slag continues to form even after the greater portion has been skimmed off, and invariably some particles are washed into the mold, resulting in unsightly castings. The only remedy, should the recommended additions of phosphor copper prove to be too high, is the gradual reduction of additions until there is no appearance of grayish, fluid slag on the surface of the melt when the induction current is shut off.

Physical Properties and Molding Practice

Using the melting practice outlined above, and casting standard test bars of the type shown in Fig. 1, the physical properties in Table 2 were attained in 42 tests. The physical properties are somewhat higher than those obtained by Kihlgren[2] on an 88-5-5-2, copper-tin-nickel-zinc alloy. Table 3 presented by Kihlgren shows the effect of lead on tensile properties. At the ordnance factory, all castings and test bars contained lead varying from 0.50 to 1.0%, yet tensile strengths below 40,000 p.s.i. were not obtained, and often were well over 45,000 p.s.i.

Table 2.—Physical Properties

	Range	*Average*	*Navy Dept. Spec. 46-M-6 Comp. G modified*
Tensile str.	40,400-47,500 p.s.i.	44,550 p.s.i.	40,000 p.s.i. min.
Yield str.			
Elong. in 2 in.	17,250-21,800 p.s.i.	18,850 p.s.i.	---------
BHN (500 Kg)	22-44%	34.6%	20.0% min.
	53-74	60	---------
Spec. grav.	8.53-8.77	8.67	---------

Table 3.—Effect of Lead on 88-5-5-2 alloy

Lead %	*Tensile strength, p.s.i.*	*% Elong. in 2 in.*
0.00	47,150	45
0.25	42,900	22
0.50	37,800	16
1.00	39,850	16

Sprues and gates should be made somewhat larger than for gun-metal. Risers are cut the same as for gun-metal, and smaller than for silicon bronze. The recommended molding sand properties are as follows:

Moisture	5-6%
AFA Green permeability	22 min.
AFA Green compressive str.	7-10
AFA Grain size	140-170
AFA Clay content	7-15%

Molds should be vented to prevent entrapment of gas. Light ramming, and baking or skin drying of large molds are recommended to help eliminate gas holes. Fast pouring, keeping the basin full at all times, is essential because of the short freezing range of nickel bronze.

Melting Practice

One great difficulty in melting this alloy in high frequency induction furnaces is temperature control. The melting is so rapid, that overheating the metal may be caused within a few minutes unless the melter is experienced and can estimate the temperature accurately by eye. Inexperienced melters should be cautious, shutting off the current before maximum temperature has been reached, taking pyrometric readings, and gradually increasing the heat to the proper point.

High temperature melting (over 2230 F.) causes excessive gas absorption and porous castings. The proper pouring range is 2060 to 2180 F.; gates, sprues, and runners must be adjusted to insure filling of the mold quickly, yet without turbulence. Melting temperature should be as close to the pouring tem-

Fig. 4. A pressure casting with a single riser.

perature as possible. The men handling the metal should be ready to remove the crucible as soon as the melting is completed. The molten metal must be skimmed, and carried to the waiting molds without delay, or the castings will be cold-shut and useless.

Fig. 2, a radiograph of a pressure casting, reveals extreme porosity caused by gas liberated from the metal before and during solidification and entrapped in the casting. The melting temperature exceeded 2300 F., and the molds were rammed very hard. Fig. 3 shows the same casting, slightly modified in design, after reduction of melting temperature to 2180 F., and casting into a lightly rammed mold.

Use of Chills

Liberal use of chills in heavier sections of a casting that cannot be fed by risers is recommended. Fig. 4 is a photograph of the casting radiographed in Fig. 3 with only one riser located at the highest point of the casting. The riser serves the triple function of feeding the dome area, allowing an escape for air and gases created within the mold, and indicating when the mold has been filled. The heavier sections are chilled—19 chills of varying size are used. X-ray examination of several pilot castings show complete freedom from shrinkage porosity (see Fig. 3), and pressure tests of these castings after machining have resulted in less than 1% rejection due to porosity.

Fig. 5. A pressure casting with three risers and 16 chills.

Fig. 6. Same casting as in Fig. 5 showing varying thickness requiring chills.

Figs. 5 and 6 show two views of another casting with three risers, yet requiring 16 chills to insure soundness. The casting with gates, risers, and sprue weighs 48 lb.; trimmed, it weighs 24 lb. Fig. 5 shows the variation in section thickness on the rim farthest from the gate—a condition conducive to shrinkage porosity unless the heavy sections are fed by risers, or chilled to equalize the cooling rates. In Fig. 6 some of the chill marks are visible on the rim and on the heavier sections.

Another illustration of the proper use of chills is revealed in Figs. 7 and 8. The radiographs were made on a casting that is subjected to hydraulic and air pressure in service. A defect such as the shrinkage porosity revealed near one of the heavy sections in Fig. 7 will cause leakage and rejection of the casting only after several man hours of machining have been performed. In Fig. 8, a cast-iron chill located in the mold adjacent to the defective area eliminated all signs of shrinkage.

Summary

A nickel bronze alloy of the type described is a suitable substitute for gun-metal and silicon bronze for many types of structural castings. A considerable saving in virgin metals can be achieved by proper utilization of scrap in the compounding of this alloy. The tensile properties of test bars containing up to 1% Pb were over 40,000 p.s.i., the minimum requirement for gun-metal (Navy Dept. Specification 46-M-6 Composition G.). Careful attention to melting, pouring, and molding practice will produce excellent pressure-tight castings.

Sincere thanks and much credit is due the author's co-workers, especially to W. A. Bourque, assistant metallurgist, for his excellent radiographs, to W. C. Sadler for his fine photographs of castings, and to John J. Nolan, foundry foreman, and his men for their unstinting cooperation in devising ways and means of producing better castings.

References

[1] E. Portman, "Silicon Bronze Castings," METALS AND ALLOYS, March 1943, pp. 526 to 532.
[2] T. E. Kihlgren, "Age Hardenable Nickel Bronze Castings," presented before AFA Non-ferrous Session of 42nd Annual Convention, May 17, 1938.

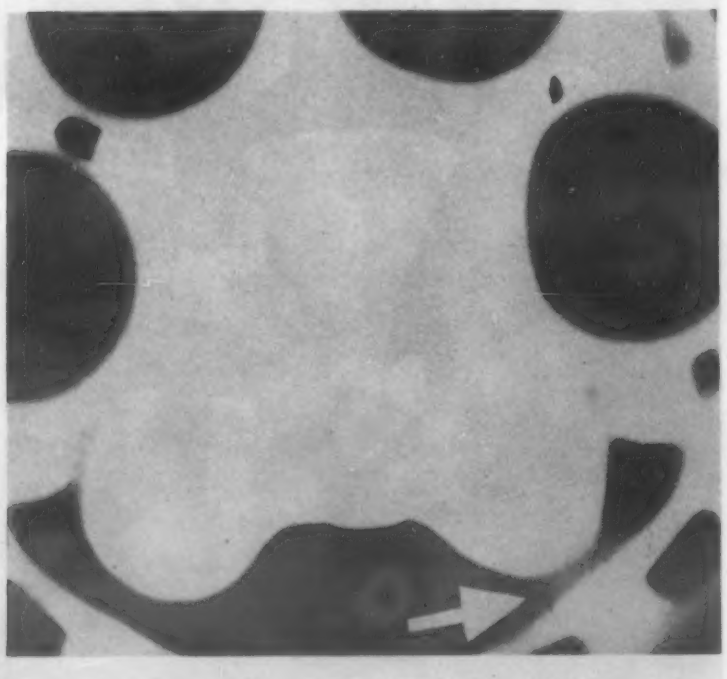


Fig. 7. Radiograph showing shrinkage crack in pressure casting caused by unequal cooling rates.

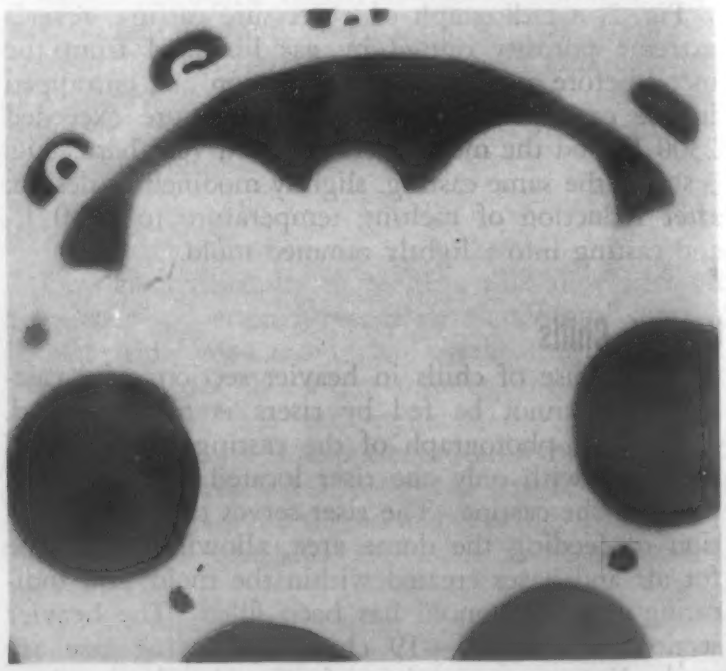


Fig. 8. Radiograph showing correction of shrinkage crack revealed in Fig. 7.

The metal-cleaning installation at Cooper-Bessemer's Mt. Vernon plant. The vats were made by workmen at the plant.

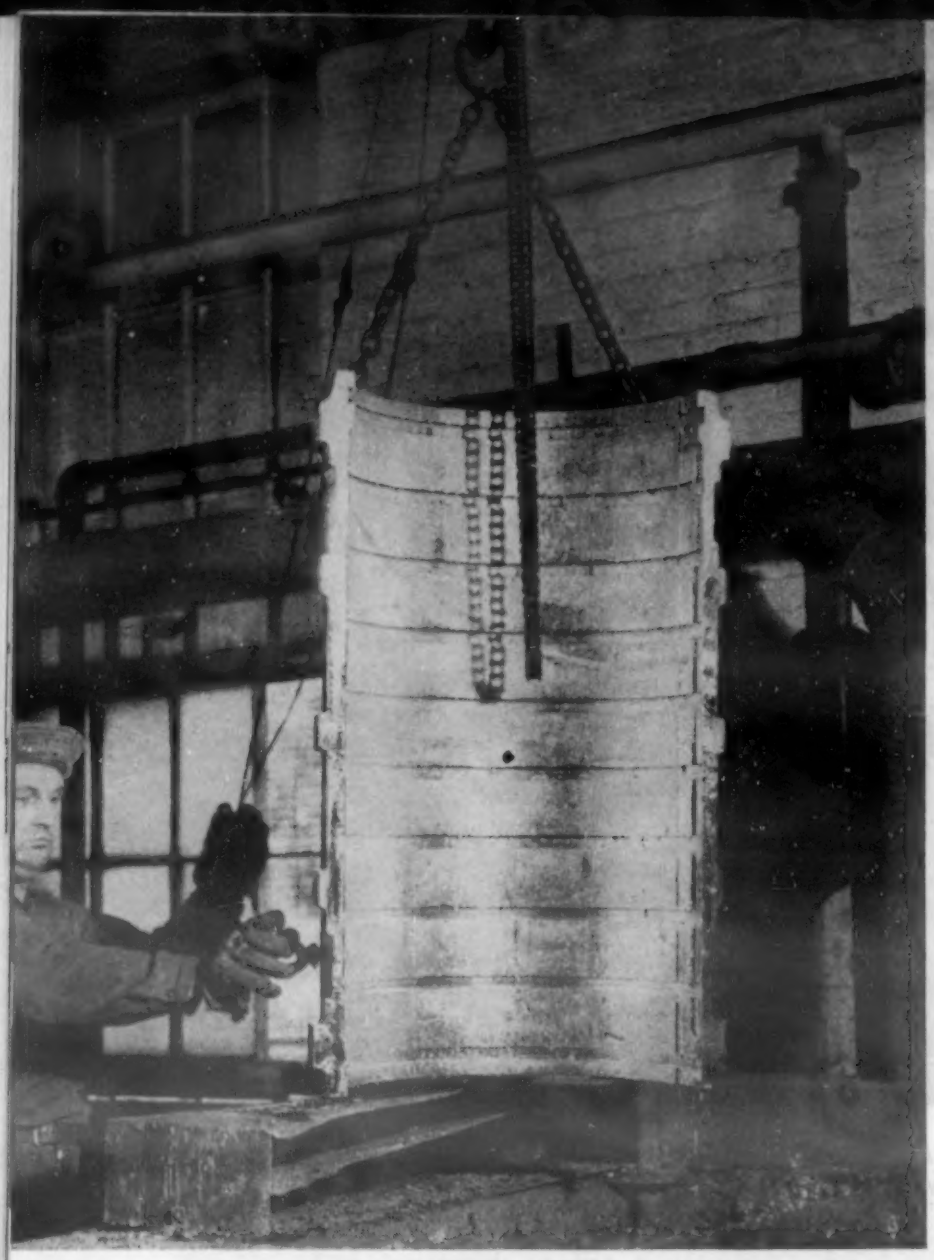
Tinning Cast Iron for Babbitted Bearings

By T. E. EAGAN *Chief Metallurgist, Cooper-Bessemer Corp., Grove City, Pa.*

In recent months increasing application has been made of a new method—the so-called "Kolene" process—for cleaning various types of metal surfaces prior to finishing operations that require an absolutely clean, readily-wet surface. In this article, Mr. Eagan describes one of the process's most valuable and interesting applications—the cleaning of cast iron bearing shells prior to tinning and babbitting, and a supplementary editorial comment discusses variations of the method and other uses. Materials- as well as process-engineers will be interested in this development because it often permits the use of materials that might not otherwise be applicable on account of unfavorable surface behavior. —*The Editors*

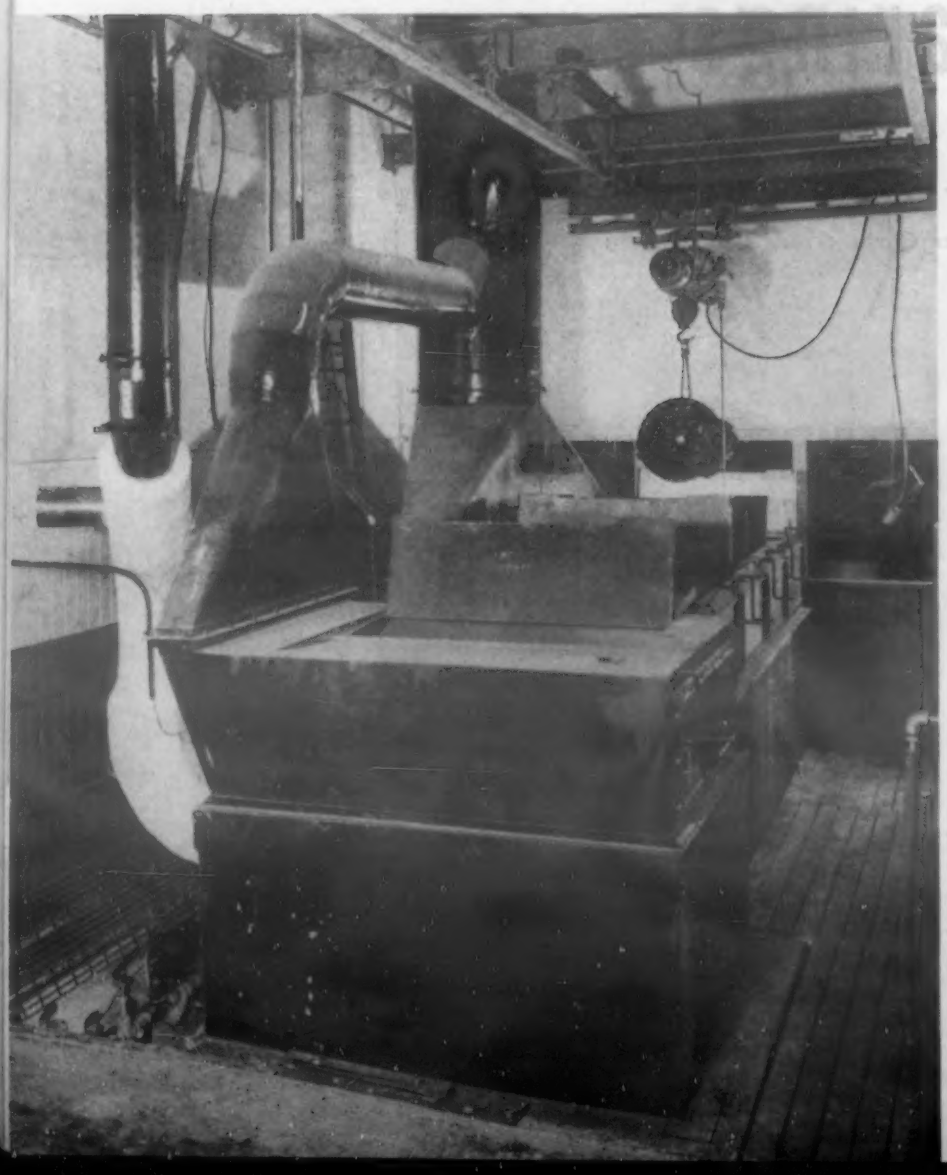
IT HAS LONG been recognized that the babbitt metal layer in babbitted bearings need not be of great thickness. Indeed, those bearings depending upon lead for anti-friction characteristics are now frequently made by electroplating a coating of this metal onto the bearing surface. The resulting bearing has the resistance to deformation of the material in the bearing shell, while the lead surface prevents seizing and galling.

These thin-babbitt bearings have usually been made with steel shells. Cast iron, although more easily and cheaply made, and at the present time more easily obtained, has always presented a difficulty in that it could not be dependably and uniformly tinned.



A 730-lb. iron bearing shell being removed from the tinning bath. The piece is now ready for babbitting.

A different type of protective hood is used to prevent splashing or spattering of liquid from this cleaning tank. (Courtesy: General Motors Corp.)



Babbitted bearings with cast iron shells therefore possessed no real bond between the babbitt layer and the shell, but depended upon anchor grooves or anchor holes to key the softer metal in position.

A comparatively recent process for preparation of metal surfaces, the Kolene process, has made possible the cheap, quick and dependable tinning of cast iron. The cast iron, once tinned, can be used as a base for a thin layer of babbitt metal that will be bonded over the entire area of contact. So satisfactory has this bonding proved to be in service that Cooper-Bessemer Corporation is now using high strength cast iron babbitted bearings, without any anchor grooves, for heavy duty in Diesel engines.

Nature of the Process

The difficulty in tinning cast iron has been that the graphitic carbon, inherent in the metal, spreads out over any machined surface and prevents bonding. Most attempts to produce a chemically clean surface, necessary to bonding, will not remove this graphite. In the Kolene process graphitic carbon is oxidized at the surface of the metal, and the oxides of iron formed simultaneously are afterwards dissolved away without exposing more graphite flakes. Graphite itself is oxidized to carbon dioxide, which combines with the alkaline constituents of the bath in which the work is immersed, forming carbonates. The surface of the cast iron is thus left with a chemically clean surface, with perhaps a very thin layer of ferrite, to which the tinning metal readily reacts to form a bond.

In operation, the first step is immersion in a molten salt bath, alkaline in reaction, containing a catalytic agent to promote oxidation. This bath is operated at 700 to 950 F., but preferably above 800 F. for graphite removal. Time of immersion may be from 5 to 30 min., depending upon the type of material to be cleaned. Low carbon steels may require only 5 min., while cast iron must be held in the bath 20 min. or more, and some alloy steels will require a half-hour of treatment.

Upon removal from the oxidizing bath the work is rinsed in water, then put into a second bath, also alkaline in nature. Metallic oxides are dissolved away without attack upon the metal itself. This second bath, a water solution of the active agents, operates at about 250 F., or just below its boiling point. Immersion time should be twice the length of time the work was held in the first bath.

A water rinse follows, and then a treatment in 20 to 30% muriatic acid is given to neutralize any remaining alkali. The work is held in the acid rinse from about 20 sec. to perhaps a minute, or just to the time when the acid begins to react with the metal. Longer action will result in the deeper graphite flakes being exposed, which will spread over the surface of the metal. A flux bath follows. An acid zinc chloride solution is used at Cooper-Bessemer Corporation, and no rinse is necessary after the acid bath. The work then goes directly into the molten tinning metal, where a few moments of swirling suffice to heat it to bath temperature, and it is removed, completely tinned.

Types of Bearings and their Production

The process has made possible the substitution of centrifugally cast babbitted cast iron bearings for the steel-backed bearings now not available in adequate quantity. Precision type centrifugally cast bearings were formerly made with a shell of S.A.E. 1010 steel tubing. Wartime demands upon the tubing mills were such that they could no longer supply the material for these shells, and, to add to the bearing manufacturer's problems, the high-tin babbitts also disappeared from the low-priority fields.

To meet these conditions the present precision bearing was developed. The shell is machined Meehanite cast iron, and the bearing metal a lead-arsenic babbitt. The composition of the babbitt is 15% antimony, 1% tin, 1% arsenic, 0.4% copper, remainder lead. This bearing metal was announced by Dr. Carl Swartz, of Cleveland Graphite Bronze Co., as being equal to the high-tin babbitts, and tests by Cooper-Bessemer Corporation have corroborated his statement. Because the tinning of the cast iron makes anchor grooves unnecessary, the shells may be made comparatively thin.

In casting the babbitt metal centrifugally, the tinned shell is placed in a small machine equipped with discs mounted in the machine's horizontal rotating axis, the ends of the shell are sealed off with the discs, the machine is started, and a measured quantity of molten babbitt metal is poured in through a tube in one of the discs. After a few seconds of rotation a jet of water is played over the shell to chill the babbitt, and the bearing, with about 1/16 in. of babbitt metal evenly distributed over the inner surface, is removed. A finish machining to size, using precision methods and tools, completes the bearing. This precision machining of the bearing is of prime importance. A bearing having the best bond and the best babbitting possible will invariably fail in service if the tolerances on the dimensions are large. The bearing must fit perfectly in its supporting back to give maximum service.

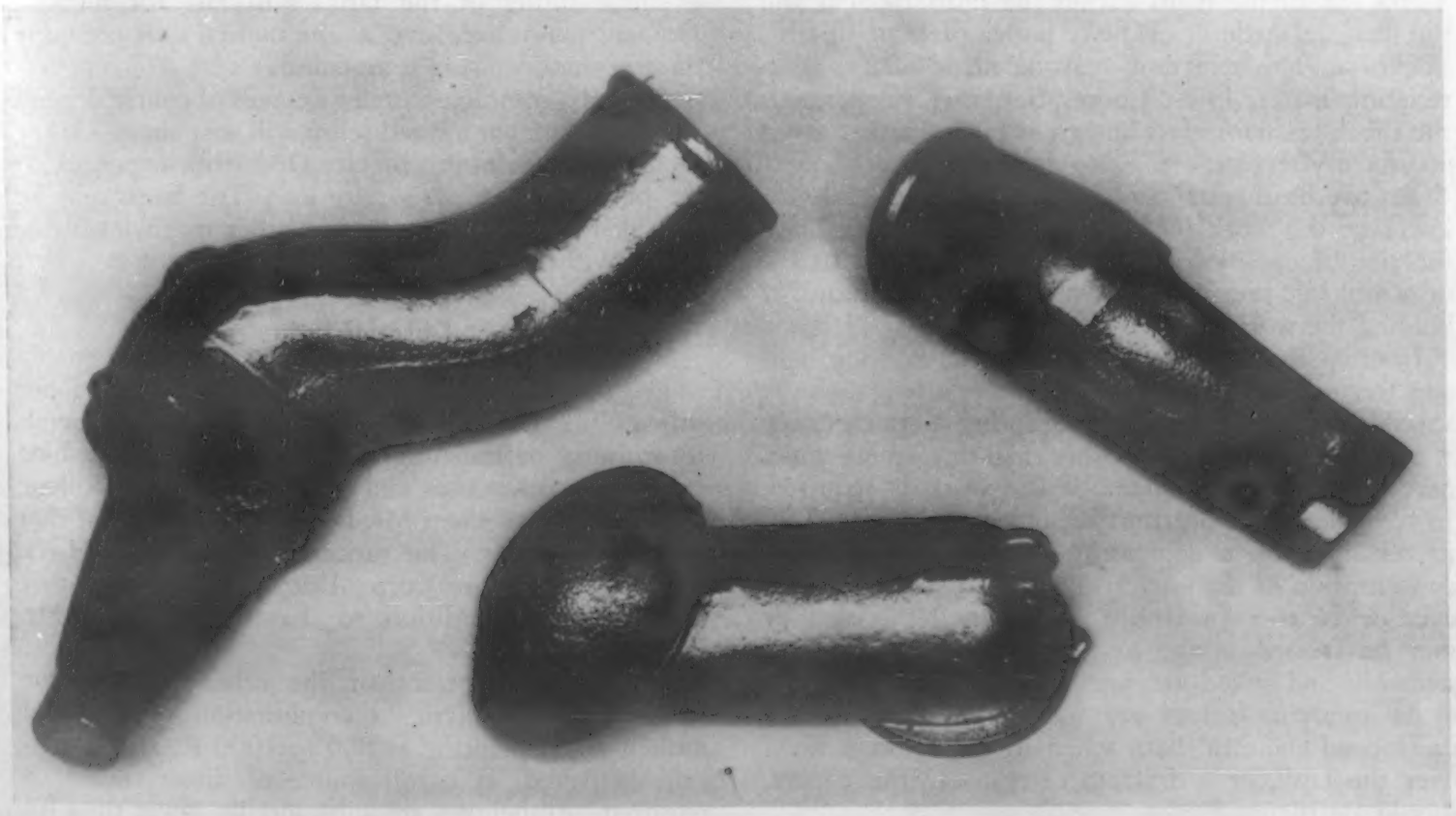
Tests and experience with the tinned cast iron have shown its superiority over the use of anchor grooves, and all engines of Cooper-Bessemer Corporation, where the application will allow, will use this type of bearing. For example, a large crosshead shoe was formerly made with ⅜ in. babbitt anchor grooves ¼ in. deep. The same crosshead shoe has been redesigned using Meehanite cast iron, no anchor grooves, and only 1/16 in. of babbitt metal.

Anchor grooves (1) give varying thicknesses of babbitt, with chances for segregation; (2) are impossible to clean; and (3) hold trapped air in the undercuts, so that the babbitt does not fill the corners (shown by sawing through test bearings).

Some Practical Observations

In addition to its ability to prepare cast iron for successful tinning, the Kolene process cleans other metals which ordinarily are tinned with difficulty. Manganese bronze, in which manganese oxides make bonding uncertain, can be prepared adequately, the oxides being dissolved in the second bath. Silicon bronze, regarded as impossible to tin properly, causes no trouble by this process. Silicon steel, which is sometimes soldered for transformer applications, can be prepared without difficulty. The process is not applicable to aluminum and magnesium alloys.

Equipment for using the process is of a non-critical nature, and no skilled help is required in operation.



These gray iron radiator castings have been cleaned and tinned overall.

Kolene installation in Cooper-Bessemer's Grove City plant. The tank at the left is the molten salt bath, followed by the water rinse, water solution, rinse, acid dip, and acid zinc chloride flux tanks in succession.

Tanks for all the baths except the muriatic acid and the flux are made of ordinary boiler plate of suitable thickness. The acid tank may be made of any acid-resisting material. At Cooper-Bessemer Corporation the shock-resistant glass known as Herculite has given satisfactory service.

An overhead crane or a chain hoist is desirable for lowering the work into the baths. Depending upon the size of the pieces being handled, a metal basket or a multiple-pronged hook offers a simple means of holding the work.

In order to avoid "spitting" in the molten salt bath any wet pieces should be dried before immersion. A splash shield around this, and the other chemical tanks, is a good safety measure. Other than this drying when necessary, no pretreatment of the work is required. In the case of old bearings being cleaned preparatory to rebabbitting, a degreasing operation will reduce consumption of the salts in the oxidizing bath. However, when there are only a few small pieces, they may be treated in the first bath even when coated with oils and coked greases.

As annoying fumes are sometimes given off by the second chemical bath when in operation, a hood over the tank, or a draft to carry away the vapors, should be planned.

The salts in the baths do not deteriorate rapidly, and, if the dragout be made up from time to time, a single filling of the tanks will last for months. Dragout is not excessive, as the molten salts are quite fluid at the operating temperature.

Cost of a complete installation will of course depend upon the size, but a small setup will cost about $3,000, including the tinning metal. Operating expenses, as has been indicated, are quite low. The baths may be heated by gas or oil, or by any other means available which will produce the required temperatures.

Editorial Note

In order to present additional information about this useful method for preparing "difficult" metals for tinning or finishing, the editors have assembled facts about other uses and other types of the Kolene process to supplement Mr. Eagan's description of that in his own plant. The process, developed by H. G. Webster of Kolene Corp., Detroit, has many other applications in addition to that described by Mr. Eagan.

The most important of the other types is the single-bath electrolytic, a combination of catalyzed molten salts operating at 800 to 1000 F., and electrically activated. A 6-volt source of direct current is required. Amperages are substantially lower than for electroplating. One lead from the line is connected to the tank, the other to the work holder, usually a

basket. It is not necessary to rack the pieces individually. A double-pole, double-throw switch allows for current reversal.

The basket containing the work is immersed in the molten salts, and the electric current is switched on, with the work the anode. This causes oxidizing chemicals to be formed in the vicinity of the work, and a bubbling action ensues. After several minutes the current is reversed, and reducing chemicals are produced at the work.

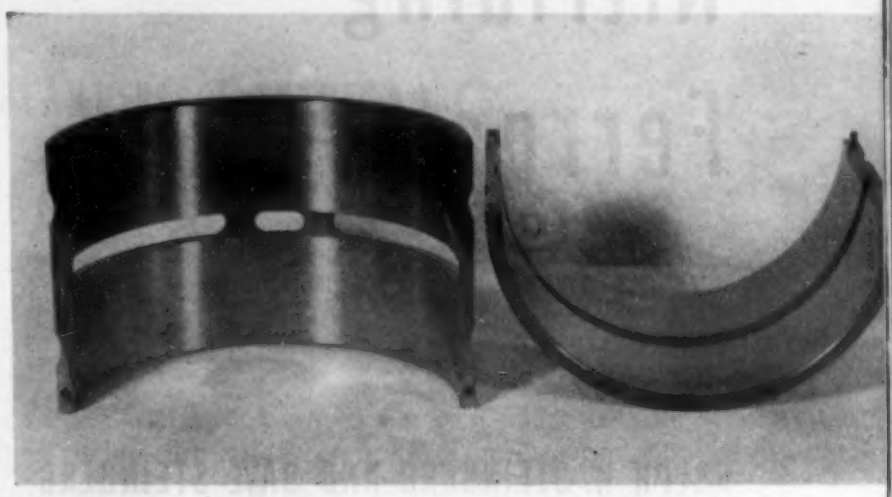
During the oxidizing cycle impurities and readily oxidizable constituents are converted to oxides. The reduction cycle which follows reduces these oxides to finely divided base metal, which is bubbled off of the work. A change to the oxidizing cycle now permits such constituents as iron carbides to be oxidized out, leaving an adherent film of iron oxide, in the case of cast iron or steel; brass or bronze yield soluble salts of zinc, tin, lead, silicon, manganese, or aluminum, with copper oxide upon oxidation, and copper upon reduction.

After a water rinse the parts may be fluxed and tinned as described before, or for certain applications where hydrogen absorption is particularly to be avoided, the acid dip may be omitted.

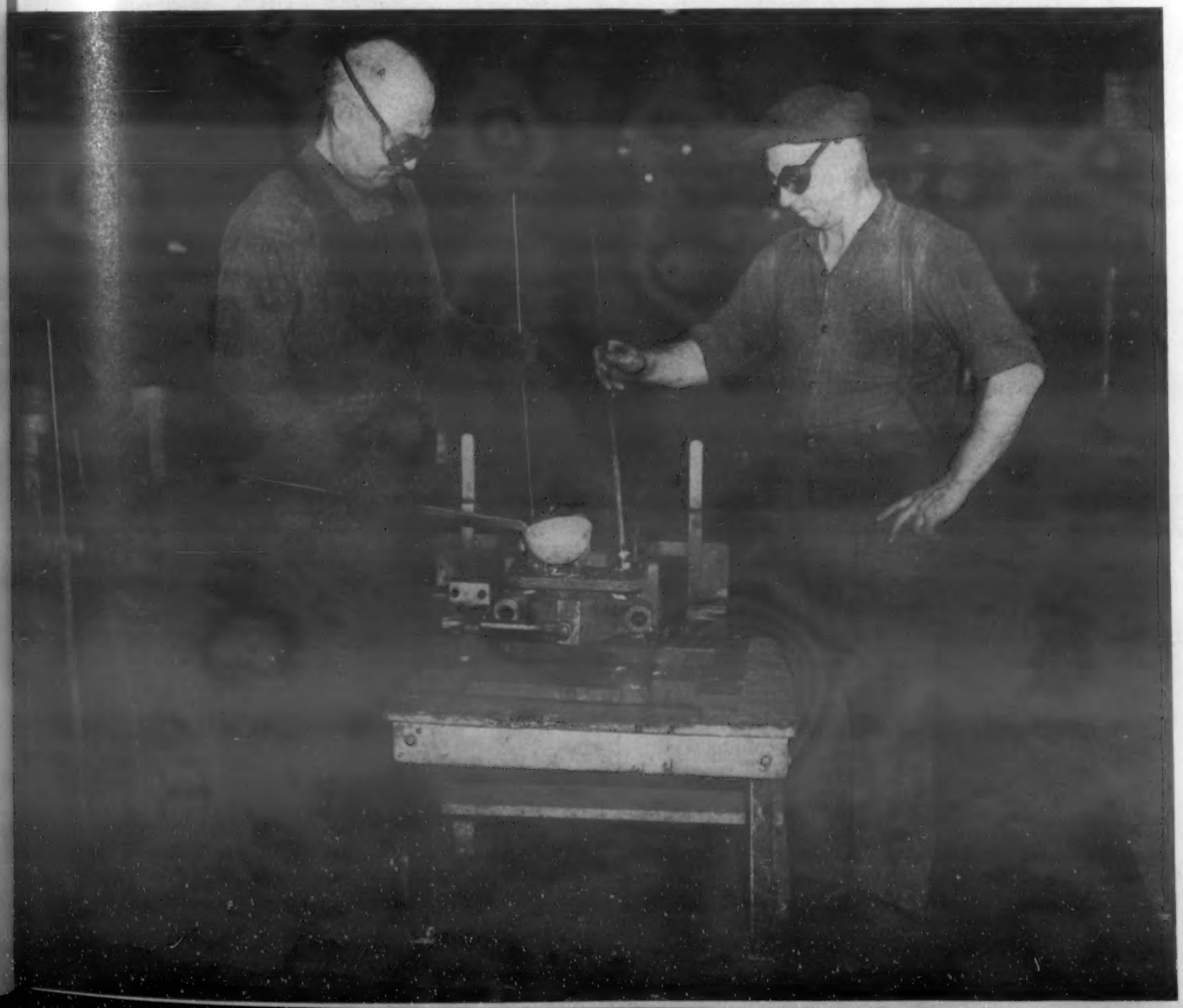
The electrolytic method is indicated where the work is heavily scaled, or for springs, enamelling stock, etc., in which hydrogen absorption must be avoided. It has been used for preparation of metals for electroplating, as a preliminary to phosphatizing cast iron or high-carbon steels as a paint base, for preparing cast iron for brazing or silver soldering, and as a pretreatment in the tinning of Alnico magnets. The two-bath method described by Mr. Eagan is more strongly oxidizing than the electrolytic process, and is more suitable where removal of paint, synthetic resins, or rubber is required. It is more efficient in the removal of coked or carbonized oils, or other carbon-base compounds, such as graphitic drawing compounds.

—K. R.

A precision-made bearing shell, with cast iron back and lead-base babbitt. The babbitt is 0.025 in. thick and the wall thickness is 5/32 in.

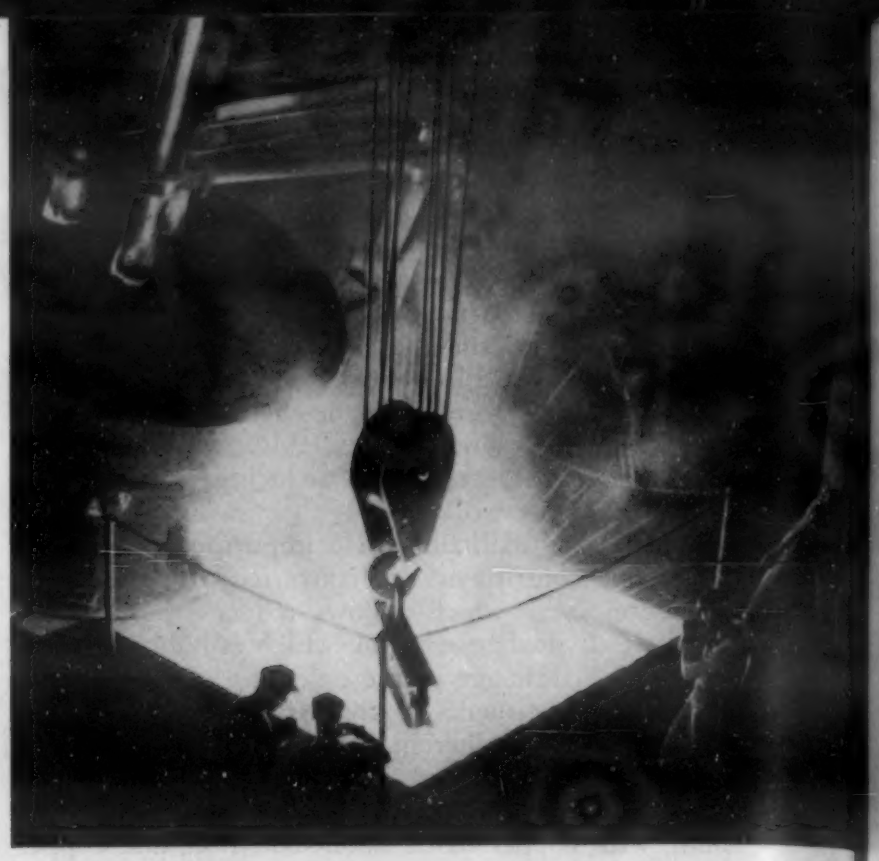


Churning procedure for static cast bearings.



Nitriding Ferroalloys

PART 2



RALPH H. STEINBERG AND DAVE STEINBERG
836 W. 71st St., Chicago, Illinois

In the previous section of this report published in METALS AND ALLOYS for April 1944, page 859, we presented the results of a temperature study of the mass nitriding of ferromanganese, ferrochromium, ferrosilicon, powdered iron and electrolytic manganese. In this section we present the results of nitriding the rest of the more or less well-known ferroalloys used in steel making, along with the nitriding of scale or ferrous oxide.

The same technique was utilized, i.e. a flow of ammonia gas at 100-125 milliliters per minute was passed over a clay boat containing the alloy, ground to pass an 80 mesh screen.

Some startling results, as shown in Table I, were obtained. Titanium and zirconium, which are generally considered to be good nitrogen absorbents, reacted unfavorably. They may have preferentially absorbed hydrogen, although we did not analyze for this element. Likewise, calcium sillicide may have absorbed hydrogen in preference to nitrogen. Molybdenum showed a definite affinity for nitrogen.

It was thought that scale might be a good raw material for the production of iron nitride through the following reaction.

$$4\ FeO + 4\ NH_3 \rightarrow 2\ Fe_2N + N_2 + 2\ H_2 + 4\ H_2O$$

The results of these experiments, as shown in Table II, were far from encouraging. The formation of water (see chemical equation) evidently inhibits the reaction, since iron produced by hydrogen reduction is easily nitrided.

Iron, manganese, ferromanganese and low silicon ferrosilicon are thus the best materials to nitride with respect to quantity and speed of nitrogen absorption (see "Nitriding Ferroalloys," METALS AND ALLOYS, April 1944). Ferromolybdenum absorbs sufficient nitrogen to make it an interesting possibility for nitride production. The other alloys studied in this paper do not offer much promise.

It is suggested that one of the possibilities of these nitrogen compounds may be their use in conjunction with aluminum to permit control of grain growth during heat treatment.

Another possibility may be the use of nitrogen additions to high speed tool steel to reduce brittleness.

The use of nitrogen in high chromium stainless steels is more or less established. However, with the accumulation of chromium stainless scrap and its use in large quantities as part of the charge in stainless melts, it will become increasingly difficult to add sufficient nitrogen as the high nitrogen ferrochromium alloy, commercially available. It is at this point that the need of other ferroalloy nitrides will become important.

Table I. Nitrogen Absorbed by Various Ferroalloys in 1 hr. at 1290 F.

Alloy	Composition	Percentage nitrogen absorbed
a. Ferrovanadium	V 38.25%, Si 8%, Co .71%	1.04%
b. Silicon-Zirconium	Zr 39.5%, Si 48.8%, Fe 11%, Co .25%	.50
c. Ferromolybdenum	Mo 61%, Co .05%	4.86
d. Ferrotungsten	W 71%, C 1.25%	2.20
e. Ferrocolumbium	Cb 57%, Si 6%, Co .27%	1.23
f. Ferrotitanium	Ti 40%, Co .04%	1.19
g. Calcium Silicide	Co .83%	0

Table II. Nitriding Scale (FeO), 100-200 mesh

Temperature °F.	Time	Percentage nitrogen absorbed	
990	4 hrs.	1.80%	deep sample
990	4 hrs.	2.70%	shallow sample
1290	1 hr.	1.95%	shallow sample
1430	1 hr.	1.78%	shallow sample

Induction Heating for Forging Shells

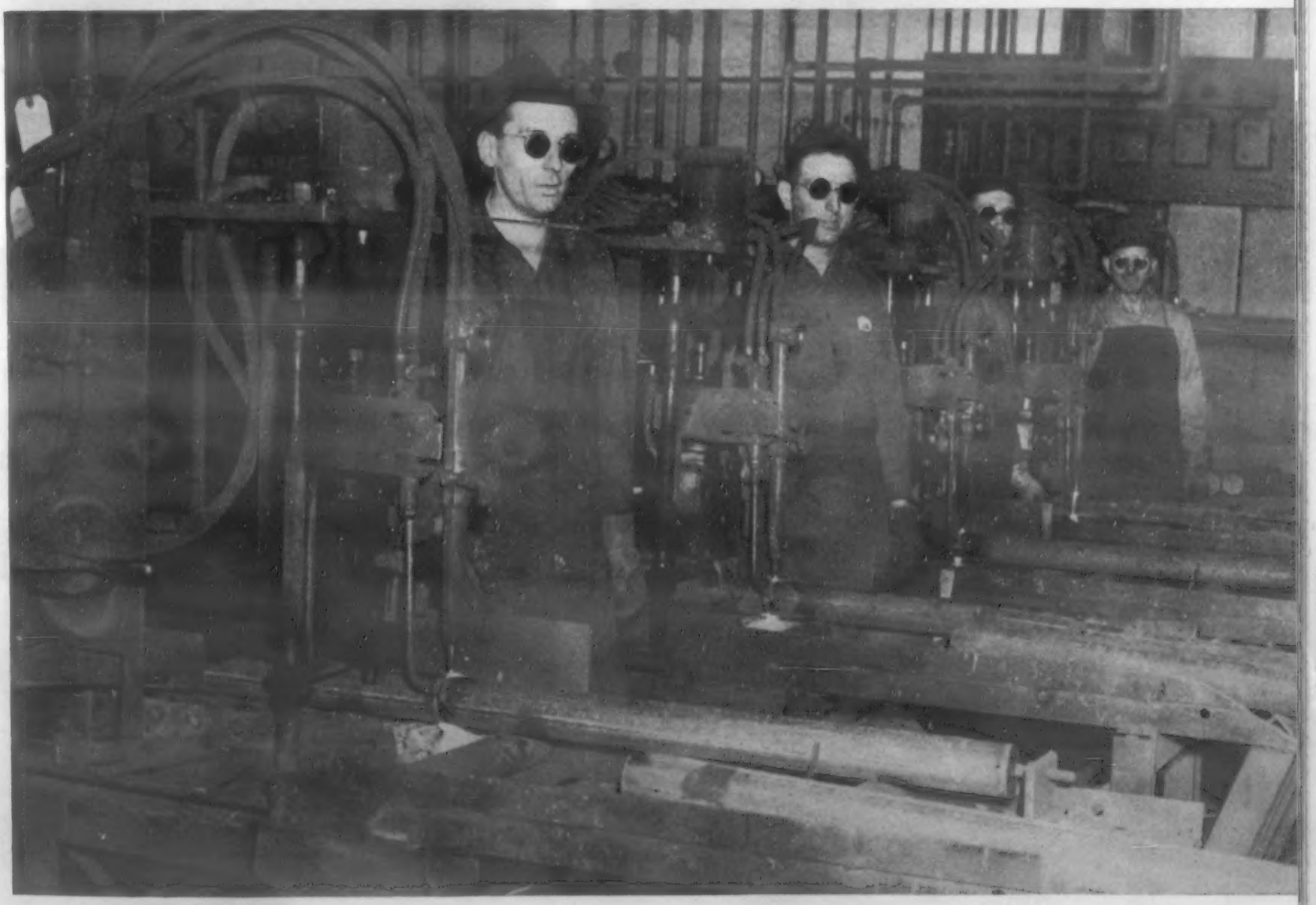
A PLANT VISIT IN PICTURES

THIRD IN A SERIES OF ARTICLES ON INDUCTION HEATING

The village smithy, with its blacksmith working with hammer and anvil while sparks fly upward, is a romantic spot in poetry, but it doesn't fit into modern production methods. Forge shop technique has been mechanized, like all other crafts. Today the hand hammer and anvil are very minor tools, and no more do sparks fly upward, for forging operations are done on machines, and heating is done in furnaces or by electricity.

At the Salem, O., plant of Mullins Manufacturing Corp., 105 mm. high explosive projectiles and 4.5 in rockets are made for the army in a forge shop in which all heating of the billets is done electrically, and all forging is done mechanically. There is no fire in the entire shop.

While war materials comprise the entire output of the shop at present, the same equipment can be converted to peacetime production of such things as wrenches, pipe flanges, aircraft cylinders, etc. —K. R.



Bar stock, the raw material for the process, is cut into double lengths by flame cutters in the billet shop. Hot rolled bars 2⅝ in. or 3 in. in diameter are used.

The double-length billets, weighing about 80 pounds apiece, are loaded onto an endless conveyor.

The conveyor carries the billets several hundred yards to the forge shop.

Because there is no fire or smoke, the forge shop is usually cool and clean. Ajax Electrothermic Corp. induction heating units and National forging machines are used throughout.

A unit in the forge shop—the induction heating equipment and forging machines. Each unit includes seven induction heaters and one forging machine.

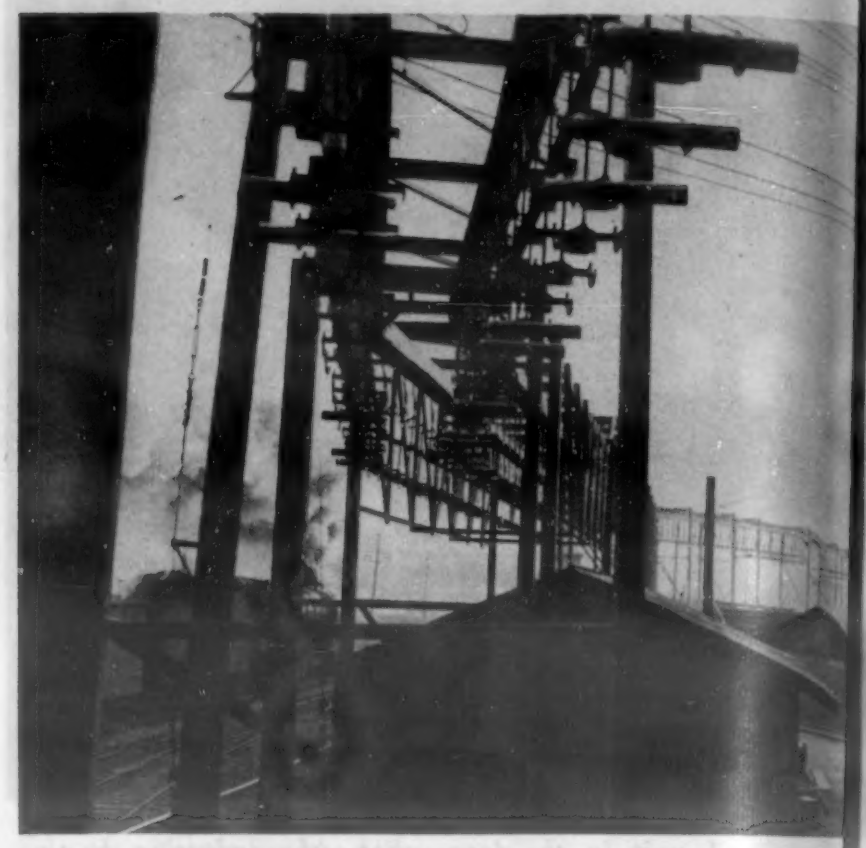
One-half of the double billet is heated to forging temperature in 3.8 min., including time for loading, heating, and unloading.

The heated end of the billet is placed in the forging machine. Each machine has six stations, starting with an upsetting operation.

The billet is lowered through the remaining stations; centering, then successive piercing operations follow. The shell is forged in less than 30 seconds, in one heat.

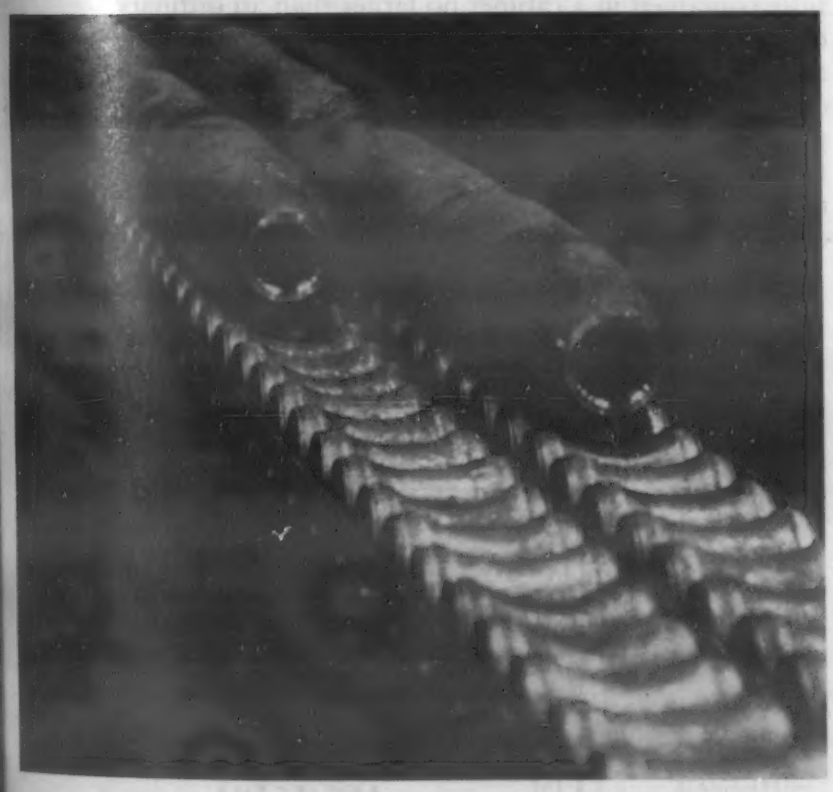
In the final station the forged piece is cut off and proceeds to the nosing machine on a roller conveyor. The stub is placed on the same conveyor that brought the billets to the forge shop.

A three-hour trip outdoors on the conveyor cools the stub, and it is then returned to the forge shop, where it is forged similarly to the first half.



Temperatures on the induction heaters are checked periodically by an optical pyrometer. Because of the speed of heating little scale forms on the billets. Only a small stub from the second forging is scrapped.

After a rough turning and centering operation the projectile is cold-nosed. These and succeeding operations take place outside the forge shop.



The heat-treated projectiles move to the machine shop on roller conveyors.

Packing the finished projectiles. While the first forgings made contained 54 pounds of metal, present rough forgings weigh only 35 pounds. The finished projectile weighs 28 pounds.

Heat treating in a controlled atmosphere furnace follows; with oil quenching to give the required bursting characteristics.

The Electron Microscope for Metals

by ROBERT G. PICARD AND PERRY C. SMITH

RCA Victor Division, Radio Corporation of America, Camden, New Jersey

Among the most promising of modern metal-control or research tools is the electron microscope, by which it is possible to examine the surface structures of metals and other materials at magnifications up to 100,000X.

The authors of this article present a general description of the instrument, describe and illustrate some of its applications in metallographic work and outline its use in diffraction studies.—The Editors

LESS THAN FOUR YEARS ago a revolutionary, new scientific tool was made available to industrial and research organizations. In this short period this new instrument, the electron microscope, has contributed mightily to our knowledge of that world which, until its advent, was called sub-microscopic.

The optical components of the electron microscope correspond to those of the familiar compound light microscope (Fig. 1). The latter instrument, however, is limited to useful magnifications of 1000-2000 diameters because of the wave nature of light, which makes it impossible to observe detail smaller than the wavelength of light (about 0.0004 mm.). The electron microscope, by using a beam of electrons rather than light to illuminate the specimen, sidesteps this limitation and allows useful magnifications up to 100,000 diameters to be obtained. Particles separated by less than 0.00001 mm. may be seen as separate entities.

At the present time a substantial number of commercial model electron microscopes are in operation and contributing daily to the war effort. These instruments are all of the original design introduced late in 1940 by RCA. However, the science of electron microscopy has advanced so rapidly in this short period that, in order to keep pace with the demands of the science, two new commercial instruments have been designed. One of these, the Universal Electron Microscope (Fig. 2), supplants the original model and features many advances in instrumentation. Designed for simplicity of operation, reliability, and operator convenience, this instrument still retains the high resolving power and great useful magnification of its predecessor, but has only half as many vacuum tubes and far fewer mechanical components. In addition to its use as a microscope, this instrument can also be used as an electron diffraction camera for the study of atomic structure of materials and, particularly, studies of surface features which cannot be investigated by X-rays because of the great penetrating power of these rays.

In addition, a compact, semi-portable, simplified electron microscope has been developed which is fully contained in a cabinet no larger than an ordinary desk (Fig. 3). Containing only 14 vacuum tubes, and capable of direct magnifications of 500 and 5000 diameters, this instrument also has the high resolving power to be expected from electron microscopes. Pictures made with this instrument can be enlarged to the same extent as those made with the larger universal microscope.

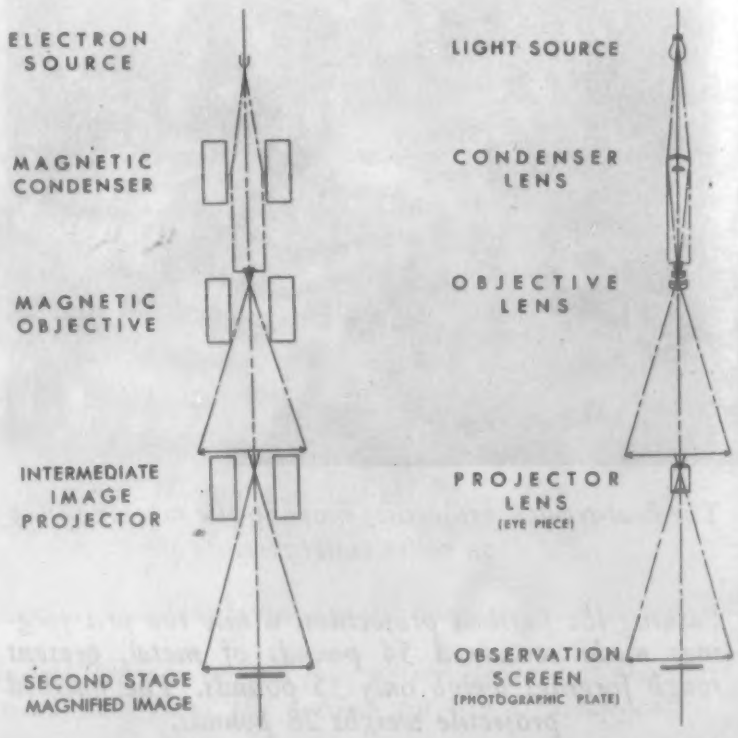


Fig. 1. Analogy between optical systems of light and electron microscopes.

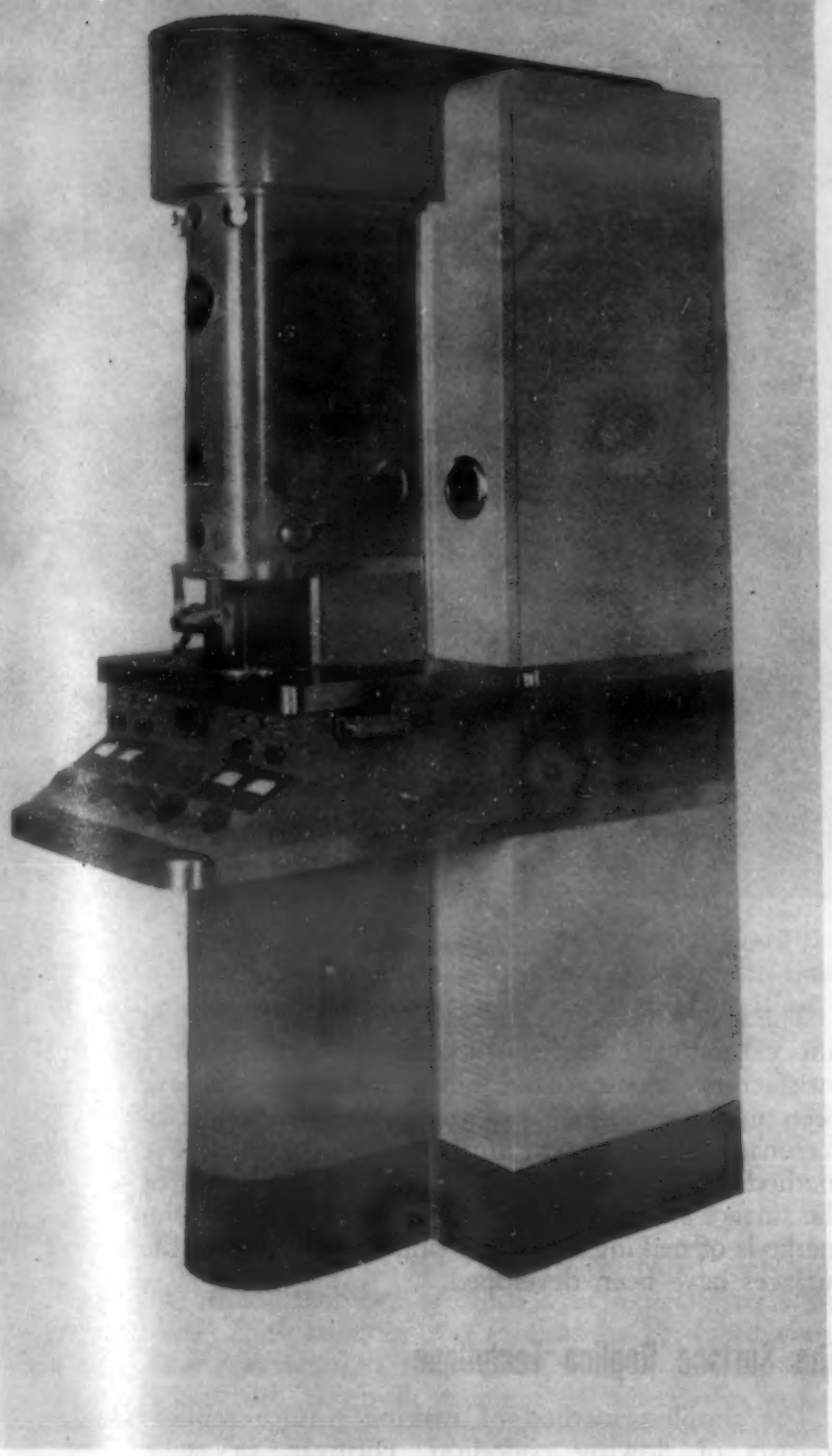


Fig. 2. New RCA type EMU universal electron microscope.

Both new microscopes are equipped for taking stereoscopic micrographs, a technique made possible by the relatively great depth of focus of the instruments. These three dimensional pictures aid immeasurably in the interpretation of crystal and surface structures.

Applications

Early in the development of the electron microscope, workers in the field of metallurgy realized the importance of this new tool and the wealth of information that could be revealed by virtue of its high resolving power. Sizes, shapes, and contours of particles previously unobservable with the light microscope were sharply revealed. However, unlike the metallographic light microscope, the electron microscope could not be used for the direct study of metal surfaces. The penetrating power of electrons is so small that the usual thin sections were opaque to the beam, and specular reflection of electrons from surfaces does not take place. However, the vistas awaiting the metallurgist and metallographer were so attractive that the more ingenious workers in these fields have developed extraordinarily successful methods for studying the fine structure of surfaces of opaque materials. By virtue of these techniques, new and fundamental information has been gained concerning crystal structure in metals, grain boundaries, phase distribution in alloys, effects of abrasion, corrosion, and etching, and other fundamental characteristics and properties of metals.

Probably the simplest investigation in the field of metals to which the electron microscope is directly applicable is the study of the structure of metallic oxides. A number of metals—notably zinc, magnesium, aluminum, tungsten and cadmium—burn in air or oxygen to form metallic oxide smokes. This smoke may be collected on the wires of a small disc of 200 mesh wire screen, the usual specimen support, and can then be studied (Figs. 4a and 4b).

It is also possible to collect these smoke particles on a thin collodion film spread over the wire mesh. Ordinary microscope slides are opaque to the electron beam, but this thin film has sufficient strength and is so transparent that it has become the standard slide for use with the electron microscope. The shape and size of the minute smoke particles can be photographed and measured directly.

Another direct application of the electron microscope to the study of metals is the investigation of the structure of evaporated metallic films. Pictures of such surfaces of metal deposited on thin films of collodion or silica have revealed the structure of these surfaces, and offer direct supporting evidence for structures inferred by such indirect methods as conductivity and reflection studies. In general, the evaporated films are found to consist of tiny particles of metal separated by interstices of measurable widths (Fig. 5). Both particle size and interstitial distances

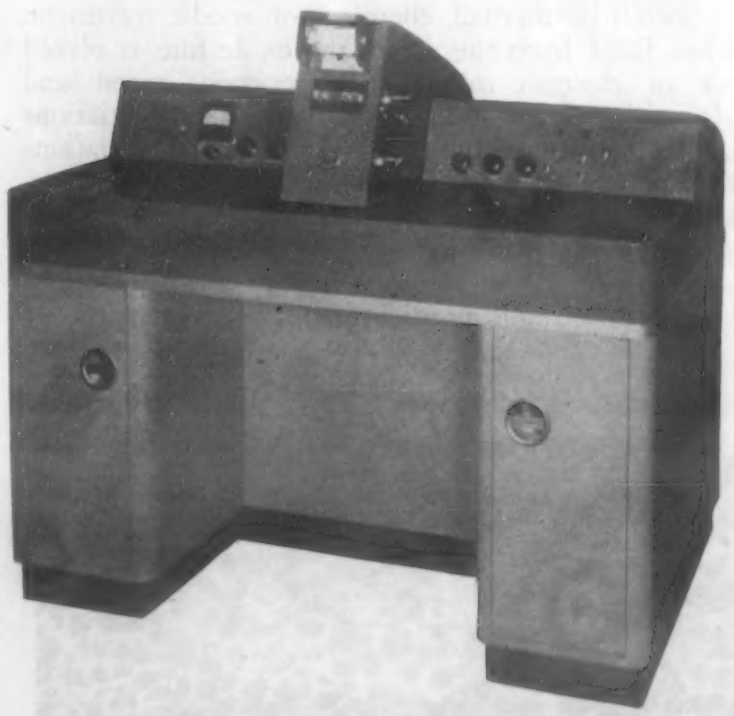


Fig. 3. New RCA type EMC console electron microscope.

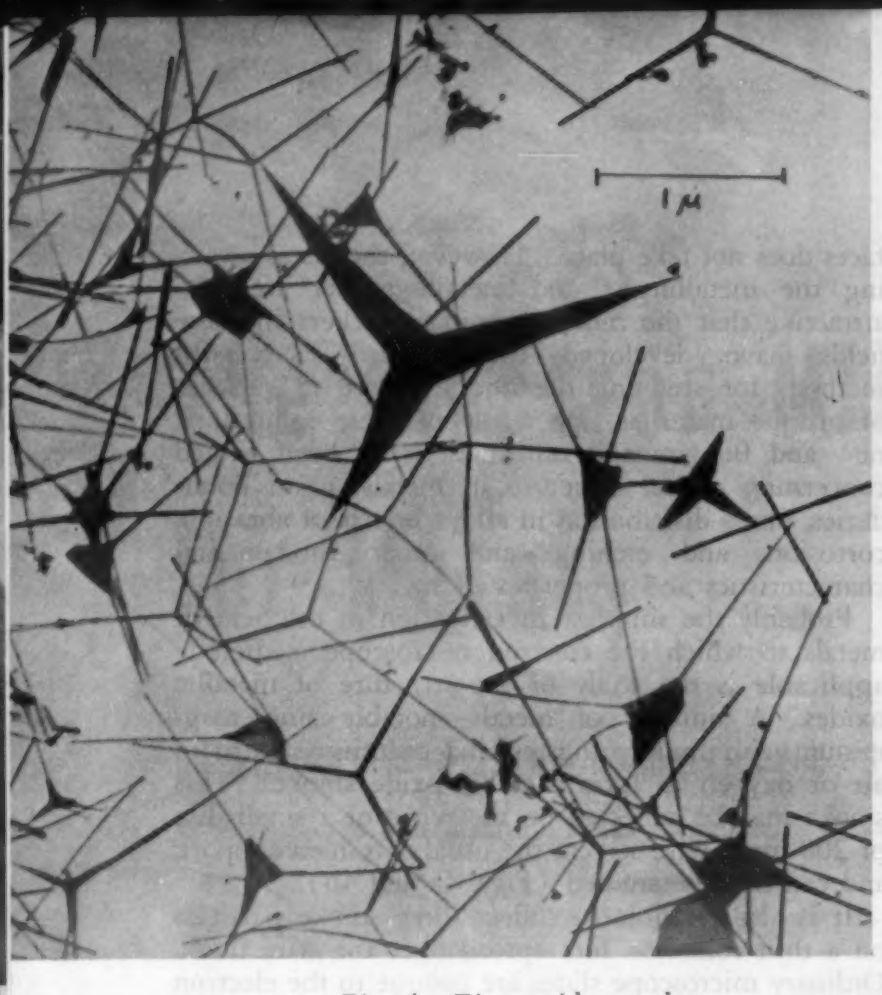


Fig. 4a. Zinc oxide smoke.

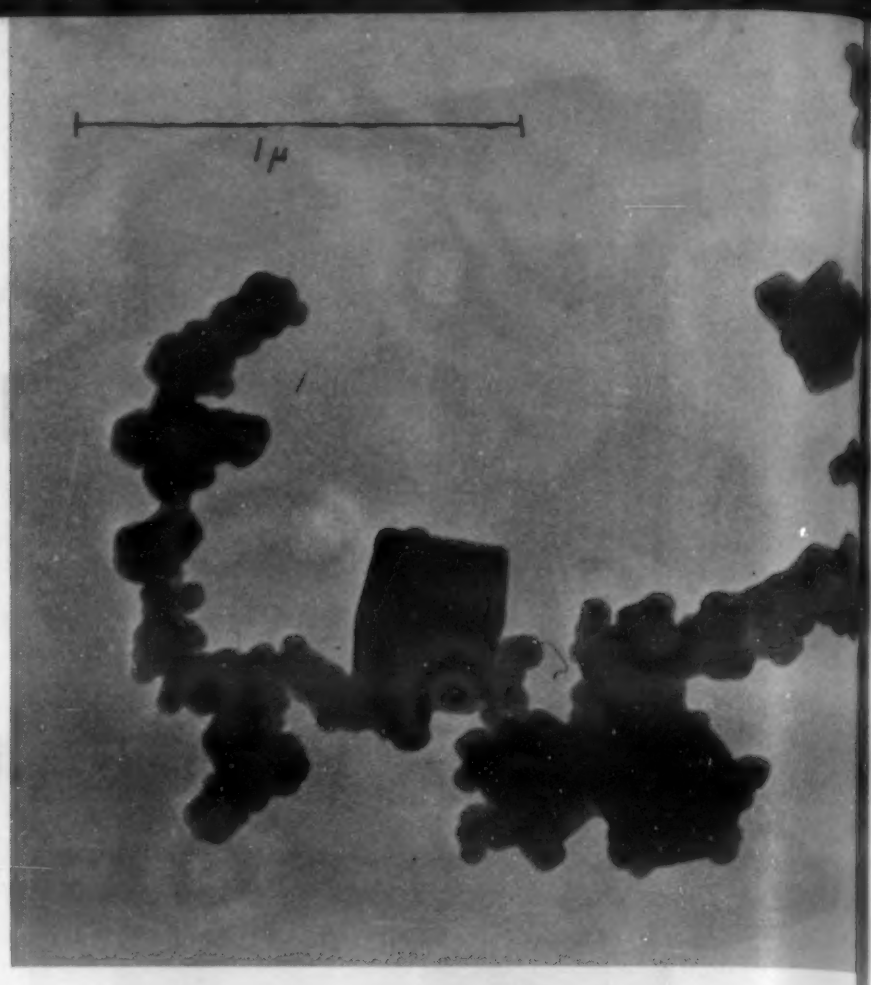
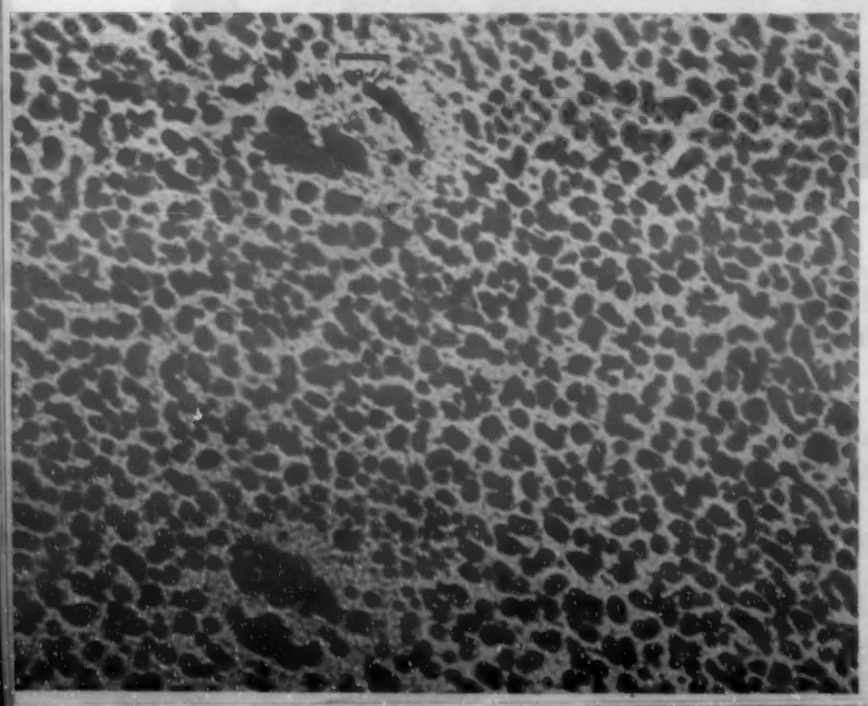


Fig. 4b. Magnesium oxide smoke.

can be measured from electron micrographs, and the effects of thickness of deposit, temperature, condition of substrate, and other factors can be observed directly. Much of this knowledge is directly applicable to work on surface protection, production of mirrors, the preparation of catalysts, and many special surface-treating processes such as the manufacture of low reflectivity glass and conducting glass.

Unquestionably the most difficult problem facing metallographers who desired to apply the electron microscope to their work was the study of the surfaces of blocks of metal. One solution to the problem was obtained by producing thin oxide films on the metal surface and then removing them by chemical means. The oxide films may be formed on a number of metals by thermal, chemical, or anodic treatment. Once freed from the metal, the oxide film is placed on an electron microscope specimen screen and viewed by means of transmitted electrons. Variations in the intensity of the image correspond to variations in the film thickness or imply the presence of particles of different density in the film. In this manner a picture of the surface and any occlusions therein is obtained (Fig. 6). Needless to say, careful interpretation of the resulting micrographs is necessary.

Fig. 5. Film of evaporated silver.

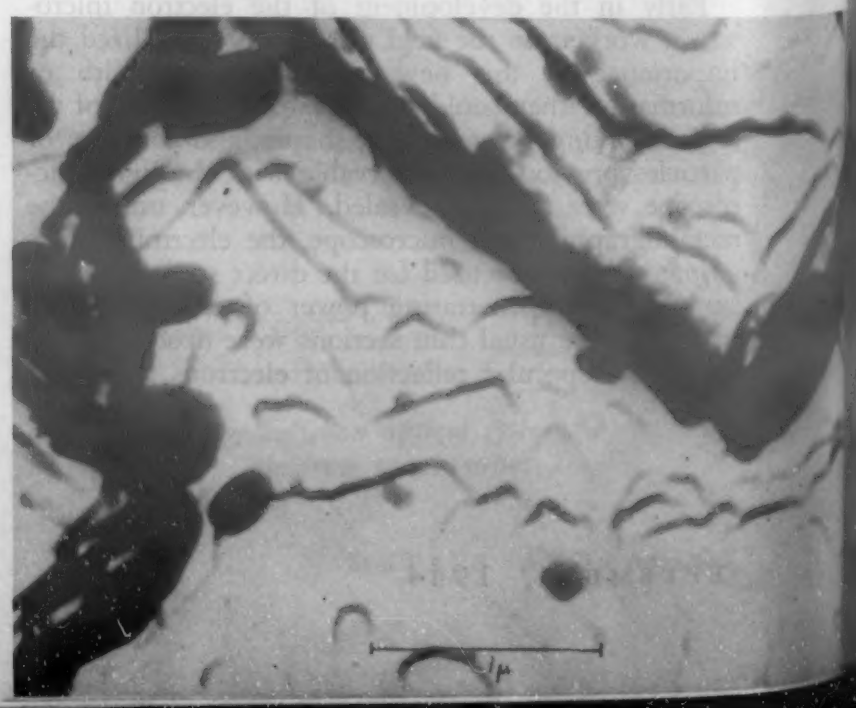


The above method is successful when the film does not exhibit a characteristic oxide structure. Very satisfactory anodic oxide films of aluminum have been made which are essentially structureless. Unfortunately, many oxide films prepared by the above methods do show a porosity which conceals much of the surface structure which is desired. For this reason methods of making extremely thin replicas of metallic surfaces have been developed.

The Surface Replica Technique

The simplest method of making surface replicas consists of flowing collodion, Formvar, or some similar material over the surface, and then stripping this thin film and using it as the electron microscope specimen (Fig. 7). Such a film is known as a *negative* replica because protrusions above the metal surface appear as thin regions (depressions) in the replica. If a *positive* replica is desired, a two-step procedure must be employed. The earliest technique consisted of making a gelatin negative replica of the

Fig. 6. Oxide film of deep etched aluminum alloy sheet showing constituent particles and block structure. (Courtesy: Aluminum Research Laboratories.)



surface, stripping this from the metal, and then flowing collodion or a lacquer over this, and dissolving the gelatin away in warm water. A later improvement involved first depositing a thick layer of silver on the metal surface to be studied, stripping this, and then flowing collodion over the silver and dissolving the latter (Fig. 8). The resulting replicas produced by any of the above methods revealed much surface detail that could not be observed in any other manner, but they frequently suffered from severe distortion because of the intermediate step involving stripping the replica from the surface.

A technique which seems to give the highest resolution of surface detail is a two-step positive replica method using polystyrene as negative material and an extremely thin silica film as the final replica.

The polystyrene is molded against the metal at a pressure of 2000-5000 pounds and a temperature of 160 C. (320 F.). The mold is then allowed to cool while maintaining constant pressure in order to prevent the formation of bubbles. In some cases the metal may be removed by sharply tapping it, or in other cases, the metal must be dissolved. The polystyrene negative is then washed with clean distilled water and dried in a stream of clean air. Onto this surface is evaporated a thin film of silica which flows over the whole polystyrene block. The silica is removed from all surfaces except that which was molded against the metal, and the block is placed in ethyl bromide. If the silica surface has been scratched into ⅛ in. squares, these small sections will float off as the solvent attacks the polystyrene, and are captured on specimen screens and observed in the microscope.

The success of this method is based upon the enormous mobility of silica over a polystyrene surface. Evaluation of the replicas so produced shows that fine detail is remarkably well reproduced. The silica film is quite structureless when observed in the electron microscope and is very transparent to the electron beam.

Once a replica has been made and mounted on a supporting screen, it can be photographed in the microscope. A picture made in this manner shows all of the detail in the replica as variations in density of the photographic image, and crystal boundaries and other regularities are readily observed. The great depth of focus of the electron microscope makes all irregularities of the surface equally sharp (Fig. 9).

However, there is one disadvantage to this large depth of focus, and that is the inability of the observer to estimate depth when all points in the field are sharply defined. This problem is readily overcome by taking a pair of stereoscopic micrographs of the field and viewing them with a stereoscopic viewer or stereo projector (Fig. 10). This is, indeed, the ideal method for studying surfaces at high magnification, as every crest and trough stands out sharply defined. By using an aerial mapping contour finder on the pair of stereo-micrographs, it is possible to measure the deviations above or below a chosen reference plane.

Another very important use of the electron microscope in metallurgy is the study of self-luminous surfaces, that is, electron emitters. Materials under investigation may be used as the microscope filament, and have their images formed on the photographic plate. Such pictures show die marks, irregularities in emission, effects of temperature, and changes in the emitter with time (Fig. 11). In those instruments equipped for electron diffraction studies it is also possible to mount an electron emitter just above the diffraction lens, and using this lens for focusing, to obtain a picture of the surface at low magnification.

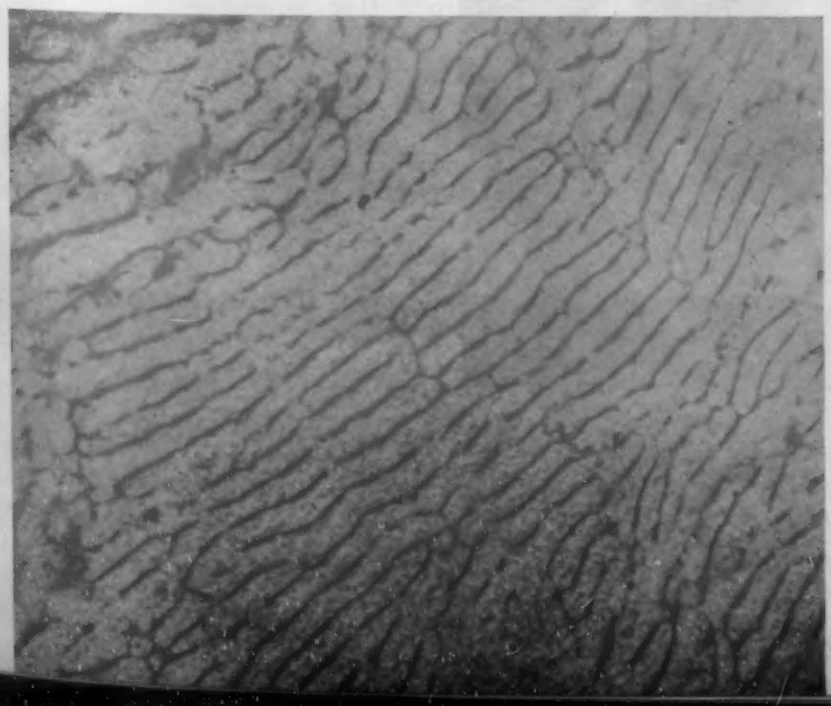


Fig. 7. Formvar replica of fine pearlite in steel.

Fig. 8. Silver-collodion replica of pearlite structure.

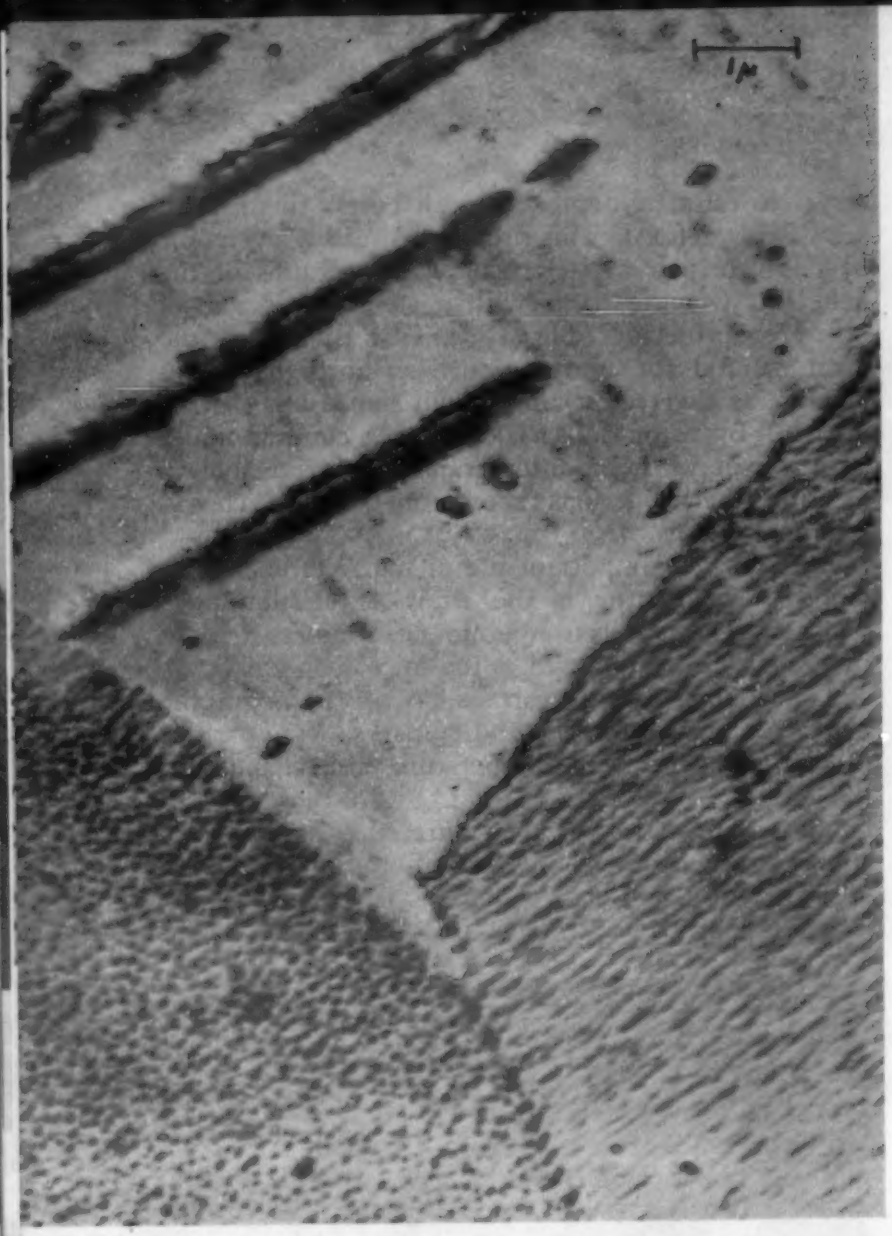


Fig. 9. Silica replica of stainless steel.

Electron Diffraction Work

As many electron microscopes are designed for use as electron diffraction cameras, the valuable technique of electron diffraction is available to many users of the instruments. For this work specimens are mounted in a special chamber just below the microscope projection lens, and above a weak lens used for focusing the diffraction pattern on the photographic plate.

There are two distinct methods of making electron diffraction patterns. With the first, or transmission technique, a beam of electrons is passed through the specimen, undergoes scattering by the material, and the diffracted beams are focused by the weak lens. Metallic smokes, fine powders and thin films of evaporated metals all produce patterns by this method (Fig. 12). From these patterns it is possible to obtain information about the crystal structure of the specimen, the particle size, and the nature of the material. It is possible not only to identify unknown substances from their diffraction patterns, but small amounts of impurities can be detected and the per cent concentration estimated.

The great majority of materials studied in metallurgy cannot be obtained in the form of smokes, powders, or thin films. To study the surfaces of such metals by diffraction a reflection technique has been developed. Appropriately polished and etched blocks of metal are inserted in the instrument and positioned so that the electron beam strikes the surface at grazing incidence. Tiny projections above the surface diffract the electrons and the pattern is again focused on a photographic plate (Fig. 13).

Because of the extremely small penetrating power of the electrons, only structures within a few millionths of an inch of the surface will contribute to the pattern. Thus electron diffraction is the only known means of examining the atomic structure of a true surface. The presence of so small an impurity as a thin film of oil on a carefully cleaned surface can effectively conceal the metal beneath. This property of electron diffraction is utilized in studies of the action of lubricants on surfaces and the structure of coatings on particles.

Fundamental physical studies in electron diffraction that can be made with the above instruments include determination of crystal lattice constants and lattice distortion when one metal is deposited upon another, measurement of the potential field within a crystal, studies of the effects of polishing surfaces, and many others.

Electron microscopy and electron diffraction are making possible a new insight into the structure of metals and reactions involving metals. In the short period of four years since commercial electron microscopes have been manufactured, their contributions in this field have been manifold. Many of the results are of vital importance to the war effort and cannot

Fig. 10. Silica replica of etch pit in pure zinc etched in hydrochloric acid. Stereoscopic pair (Courtesy: Dow Chemical Co.).

Fig. 11. Electron image of incandescent tungsten wire showing irregularities in emission.

be revealed until national security permits. However, the value of this new tool can be estimated in terms of its rapid acceptance and the volume of work which it is accomplishing.

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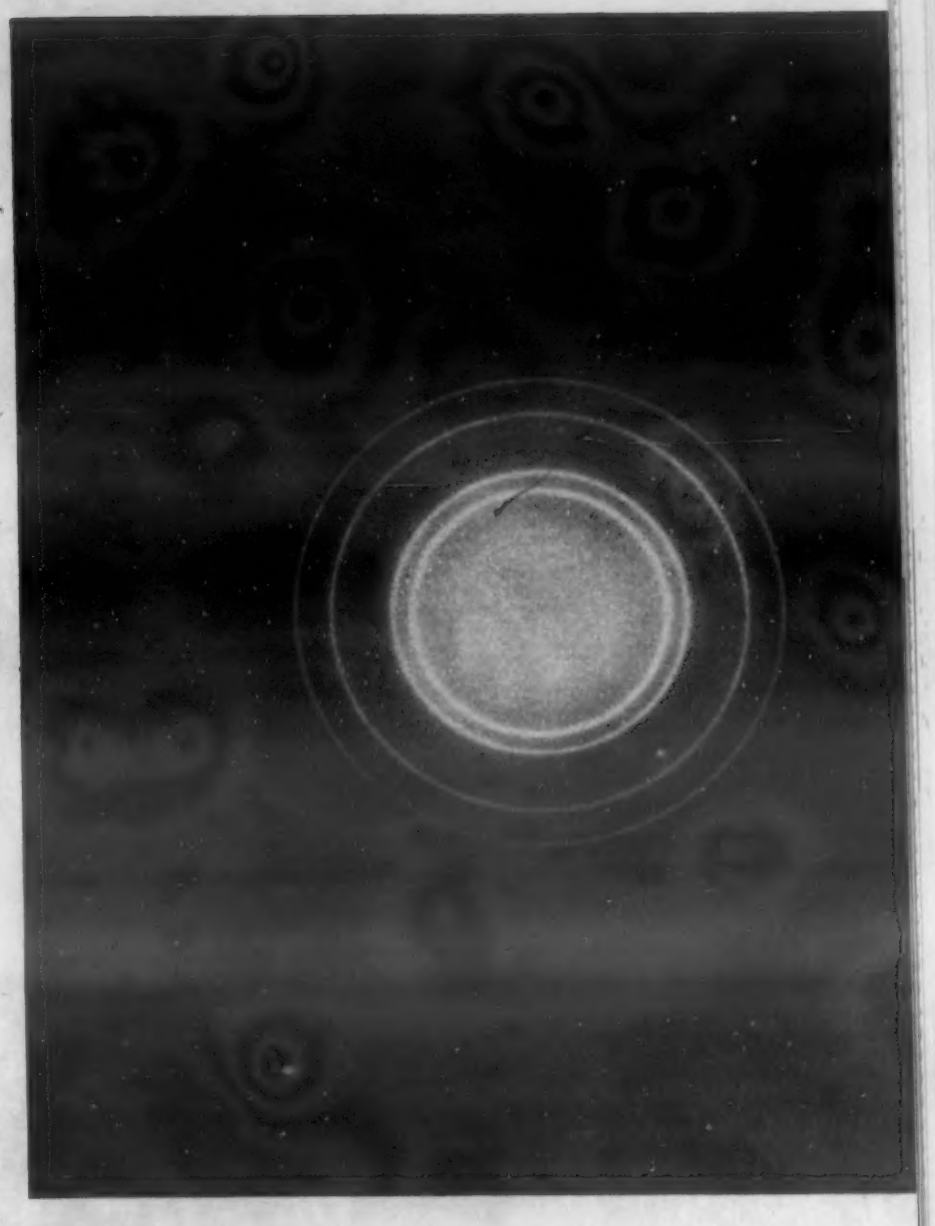


Fig. 12. Transmission diffraction pattern of aluminum.

Fig. 13. Reflection diffraction pattern of silver.

Strong Cast Aluminum Alloy

—REQUIRING NO HEAT TREATMENT

by ALBERT J. MATTER

Chief Mech. Engr., Oscar W. Hedstrom Corp., Chicago, Ill.

Since the beginning of the war emergency period there have been developed and introduced to industry a small number of highly useful aluminum casting alloys that provide high as-cast *strength (i.e. without heat treatment) and other advantages. This article presents the engineering properties of and some service test results on one of these—"OH38" aluminum alloy, manufactured by the author's company. The article will interest both design and foundry engineers.*
—The Editors

ONE OF THE BRIGHTEST spots in the new-alloy picture of recent years has been the availability of strong aluminum alloys whose as-cast properties are such that they require no heat treatment (either hardening or annealing) to fit them for heavy duty service and which have other desirable working properties or performance features. Among these is the aluminum alloy "OH38," described herewith, which has the following general properties: Strength equivalent to heat-treated cast alloys, freedom from shrinkage or growth, easy machining, non-sparking behavior, good corrosion resistance and the ability to outwear brass or bronze in certain types of bearing applications.

The alloy, which contains aluminum, zinc and manganese, can be produced from secondary aluminum alloy. It is believed that the exact combination of properties it provides is unique among aluminum alloys. The outstanding property—high as-cast strength without the necessity of heat treatment—is important in saving the cost and production-time otherwise required for hardening and in obviating subsequent straightening operations to correct distortion introduced by the heat treating process.

Engineering Properties of the Alloy

A tabulation of the properties of the alloy of interest to application-engineers follows:

Service Properties	Working Properties
Tensile strength..34,000-38,000 p.s.i.	Requires no hardening or annealing
Elongation 2-4%	Requires no straightening operations
Brinell hardness ..... 98.5 (average)	Machines easily; threads can be cut to sharp edges that will not rupture or split
Specific gravity 2.88	Polishes to mirror-like brilliancy
Wt. per cu. in. ..... 0.106 lbs.	Can be anodized or plated with chromium, nickel or tin
Coeff. of linear exp. ..... 13.5×10^{-6} per deg. F. between 70 and 300 F.	
Conductivity .... 33-1/3% of copper's	
Non-magnetic	
Non-sparking	
Dimensionally stable—can be used for precision instruments measuring to 0.0001 in.	
Good bearing and wearing qualities (0.005 in. wear in 5000 hr. at 3500 r.p.m. using motor mica in No. 10 machine oil.	

Initial stage in the manufacture of OH38 aluminum alloy. Shown here are furnace tenders placing crucible with molten metal in rack which will carry it to molds for pouring.

Some Service Tests

To exemplify uses and tests to which OH38 aluminum alloy has been put, a few examples are in order.

One engineering company, which was skeptical as to the practicability of aluminum for use as hand locking nuts, ordered some castings of OH38 aluminum and machined two units for test. One nut was tightened 10,000 times with a torque of 55-in.-lbs., and the second 14,000 times. At the end of the test the company reported all threads were in perfect condition and absolutely no mushrooming was indicated at face. One nut was operated dry, and the other lubricated with 600-W oil.

Another firm of engineers made comparative tests between OH38 and another, well-known, aluminum alloy. Tests were made of two castings (rocker arms), 8 in. long, one made of OH38 and the other of the other alloy. A Brinell test with 500 kilogram load was made on the side of each. Transverse strength test was made on 6 in supports, with the load on 1 in. rd.

Molders remove aluminum alloy castings from the sand.

at the center of span, and deflection directly underneath. The following results were obtained:

Test	OH38	Competitive Alloy
Weight of sample—grams	127	115
Brinell hardness No.	98.5	94
Deflection at 750 lb.—in.	0.009	0.13
Deflection at 950 lb.—in.	0.13	0.18
Deflection at maximum load—in.	0.20	0.27
Maximum load—lb.	1085	970
Failure point	Under center	Under center

A radio manufacturer who has been using alloy OH38 states they have found it very stable and uniform in thermal expansion and contraction, so that electrical compensation can also be uniform.

An automobile manufacturer, considering the metal for use in the manufacture of certain parts of the cars it makes, conducted a series of tests, one of which was the drilling and tapping a 5/16-18 hole in the casting and screwing a 5/16-18 hex head cap screw into this hole and then, using a torque wrench, driving the screw to a 40-lb. torque, at which point the head twisted off the screw. The threads, however, showed no tendency to rupture or strip out.

Corrosion tests have shown the alloy to be immune to the corrosive effects of carbon tetrachloride, lactic acid, ammonia, vinegar, and potato juice.

The foregoing descriptive outline should serve to give a reasonably clear picture of the applicability and workability of OH38.

An Oscar W. Hedstrom Corp. machine shop at work on OH38 alloy.

Subzero Treatment to Improve Tool Life

No. 4 in a series on Refrigeration in the Metal-Working Industries.

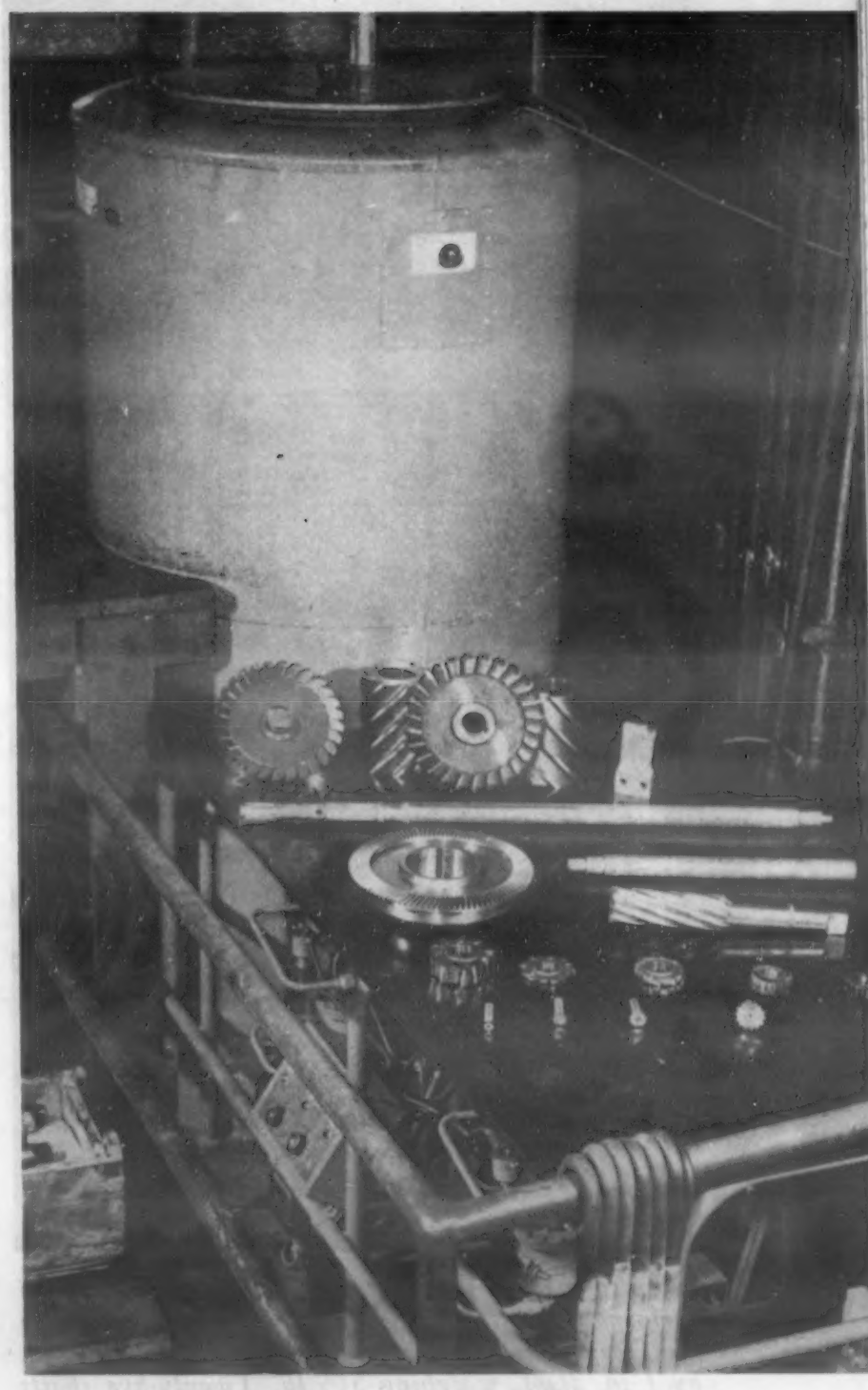
by STEWART M. DePOY

Metallurgist, Delco Products Division, General Motors Corporation, Dayton, Ohio

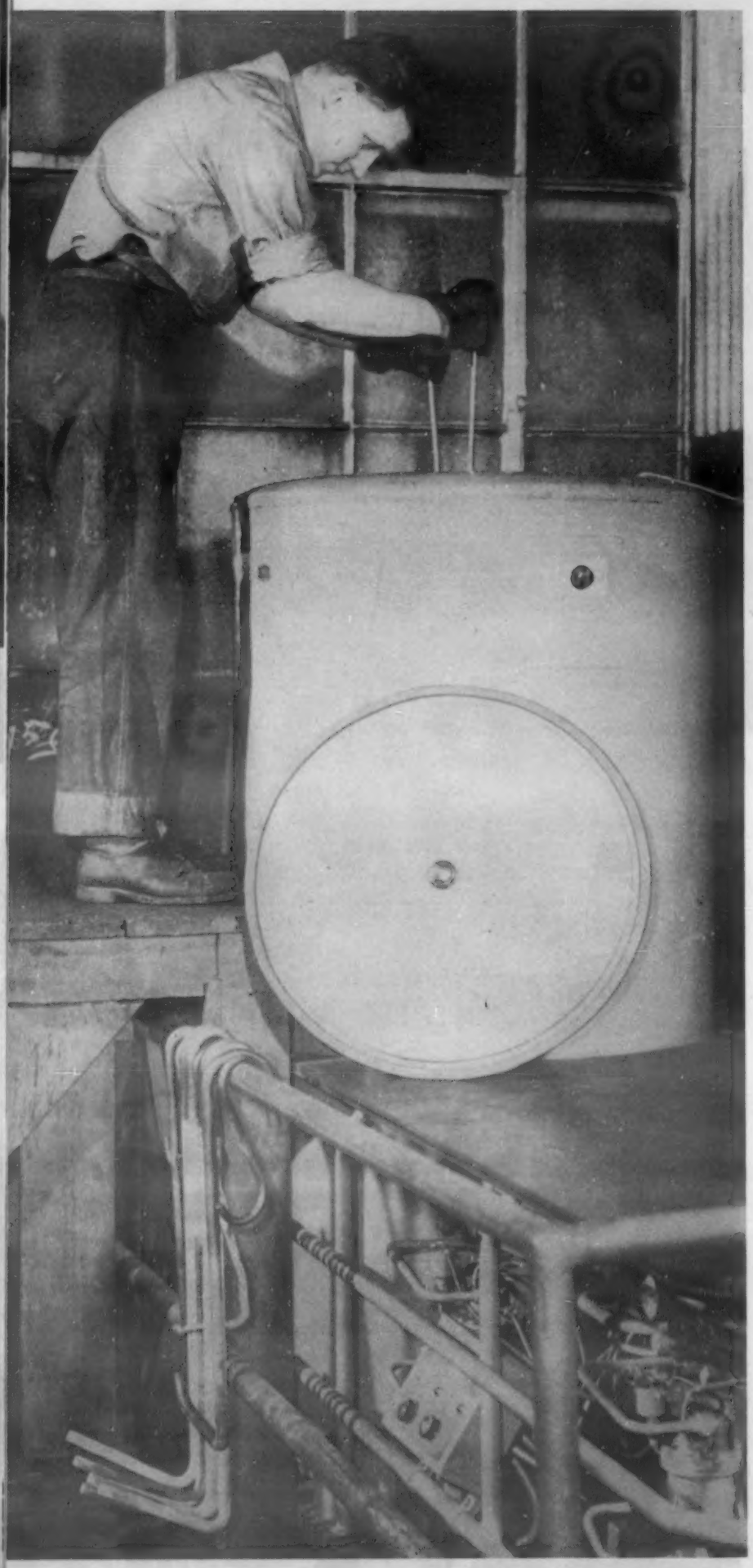
The previous article in this series (Mar. 1944, p. 610) reviewed the use of refrigeration for stabilizing gages in a fraction of the time conventionally required to "age" them, and hinted at a dawning recognition that the hardness and other properties of the steels are also improved by cold treatment. Mr. DePoy has investigated this and reports here some of his practical findings on the extraordinary life extensions or productivity increases enjoyed by steel tools subjected to refrigeration at selected subzero temperatures during the hardening cycle. His views on why these results are achieved and some interesting comments on the use of subzero treatment for strain-relief are also included.—The Editors

FIFTEEN YEARS AGO refrigeration of carbon and low alloy tool steel was investigated by gage makers to ascertain the possibilities of stabilizing gages. This so-called "aging" process, as it was termed at that time, met with different degrees of success. The inconsistency was due to prior heat treatment, and the intensity of the cold treatment. However, today we know that refrigeration of these materials at—48 F. for a short period will transform all retained solution into the hard structure called martensite. This phenomena led investigators to attempt refrigeration on the high alloy or "sluggish" hardening materials.

The very nature of the highly alloyed tool steels makes them extremely susceptible to retained austenite (the solution structure). Certain faults in the heat treatment of these steels will tend to stabilize this austenite, thus rendering it almost impossible to transform by standard heating and cooling processes. In 1942, Morris Cohen of the Massachusetts Institute of Technology discovered that the transformation could be very easily forced to completion in high speed steel, if the material were subjected to subzero temperatures of—100 F. or lower following austenitizing. The publication of Cohen's work immediately



A few cold treated tools and machine parts appear here after removal from the Deepfreeze Cascade minus 120 F. industrial sub-zero chilling machine.



Sub-zero machines are versatile in the work they can perform. Here table lead screws are being placed in the Deepfreeze for treatment. Each shaft is 30½ in. by 1 in. diam., weighing 5½ lb. Twenty-five shafts are placed in the 60 in. chilling compartment at one time. The treatment gives 2 to 3 points Rockwell C extra hardness, state Deepfreeze officials.

stimulated investigation of refrigeration of high alloy tool steels in the industrial field.

It now becomes apparent that the refrigeration has effects on the material other than simply enhancing the transformation of austenite to martensite. If a high speed steel is double tempered at 1050 F. (tempered at 1050 F. for 2 hrs. cooled to room temperature and re-tempered for 2 hrs. at 1050 F.) following proper austenitizing procedure, 98-99% of the austenite should be transformed. However, subjection of the material to refrigeration in conjunction with the hardening treatment raises the productivity of high speed steel from 10 to 200%.

It does not seem possible that such an increase can be obtained merely by the transformation of an additional 1% of austenite. Consequently, the writer has made an attempt to find other structural changes which may be caused by the refrigeration. That refrigeration is effective on high speed steel is demonstrated adequately by a technical paper by the author, "The Effect of Grain Size and Subzero Treatment on the Productivity of Four High Speed Steels," American Society of Mechanical Engineers' Paper No. 44—SA7, June, 1944. Tables I, II, and III of this article are taken from that paper. Treatments of the materials studied were as follows:

Preheat (All Treatments)	1650 F. for 30	min.
High Heat: Treatment 1	2175 F. for 2½	min.
Treatment 2	2225 F. for 2½	min.
Treatment 3	2275 F. for 2½	min.
Treatment 4	2300 F. for 2½	min.
Treatment 5	2325 F. for 2½	min.
Treatment 6	2350 F. for 2½	min.
Treatment 7	2410 F. for 2½	min.

Quench in salt (all treatments)—1100 F. for 3 min.
Cool in air to 100-150 F. (all treatments)
Wash thoroughly (all treatments)
Double temper at 1050 F. for 2 hr. (all treatments)

Refrigeration Improves Tool Life

The refrigerated samples were treated exactly the same except that they were refrigerated at —105 F. *between the tempers.*

The tools were ⅜ in. square tool bits. The surface speed was held at 200-219 f.p.m. The depth of cut was 0.050 in. and the feed 0.0075 in per revolution. "P" shown in Table III was calculated as follows:

P = Volume of metal removed = Productivity
= Depth of cut x 12 x Speed (f.p.m.)
x feed x Operating Time
= .0045 x Speed x Operating Time.

From Table III it is immediately evident that refrigeration is effective. It may also be seen that the treatment prior to the refrigeration greatly influences its effectiveness. Moreover, it is apparent that the size of the grain in material that is not refrigerated also affects the productivity of the tool. However, it is not the purpose of this treatise to discuss the latter phenomena.

Tools refrigerated directly following the quench also give increased productivity. However, most of the author's work has been done with the refrigeration following the first temper at 1050 F. It was believed that refrigeration following the quench was

Table I. Types of tool steels subjected to treatment.

Spec. No.	Trade Name	Source	Heat No.	Chemical Composition — % C	Mn	Si	P	S	Cr	W	Mo	V	Co	Ni
NE-8620	NE-8620	Timken Steel & Tube Div.		0.20	1.03	0.29	0.014	0.016	0.49	—	0.17	—	—	—
M-2	Electrite Double Six	Latrobe Electric Steel Co.	20392	0.85	0.29	0.21	0.028	0.012	4.12	5.78	4.57	1.59	—	—
M-36	Electrite CO-6	Latrobe Electric Steel Co.	44038	0.86	0.31	0.33	0.022	0.014	4.07	5.39	4.41	1.65	8.63	—
T-1	Electrite #1	Latrobe Electric Steel Co.	21003	0.73	0.34	0.32	0.029	0.009	4.07	17.76	—	1.07	—	—
T-5	Electrite Super Cobalt	Latrobe Electric Steel Co.	44041	0.85	0.29	0.25	0.027	0.012	4.30	18.03	0.78	1.94	8.56	—

Table II. Comparison of properties of tool steels when treated conventionally and when refrigerated.

Material	Treatment	Hardness—Rc		Impact—ft. lb.		Grain Count (Intercept)	
		Standard	*Subzero*	*Standard*	*Subzero*	*Standard*	*Subzero*
M-2	1	63.5	65.0	33	29	9½	10
M-2	2	63.5	66.5	42	15	10½	6½
M-2	3	64.0	67.0	7	6	8	7
M-36	1	64.0	66.5	18	12	8½	8
M-36	2	64.0	67.0	21	7	8	6½
M-36	4	64.5	67.5	4	4	4	4½
T-1	3	63.0	65.0	31	32	11	11½
T-1	5	63.5	65.5	20	51 *	10	12
T-1	7	63.5	66.5	8	8	5	6
T-5	4	64.0	66.5	15	13	10½	7½
T-5	6	64.5	68.0	4	4	6	6
T-5	7	65.5	67.0	4	4	5½	5

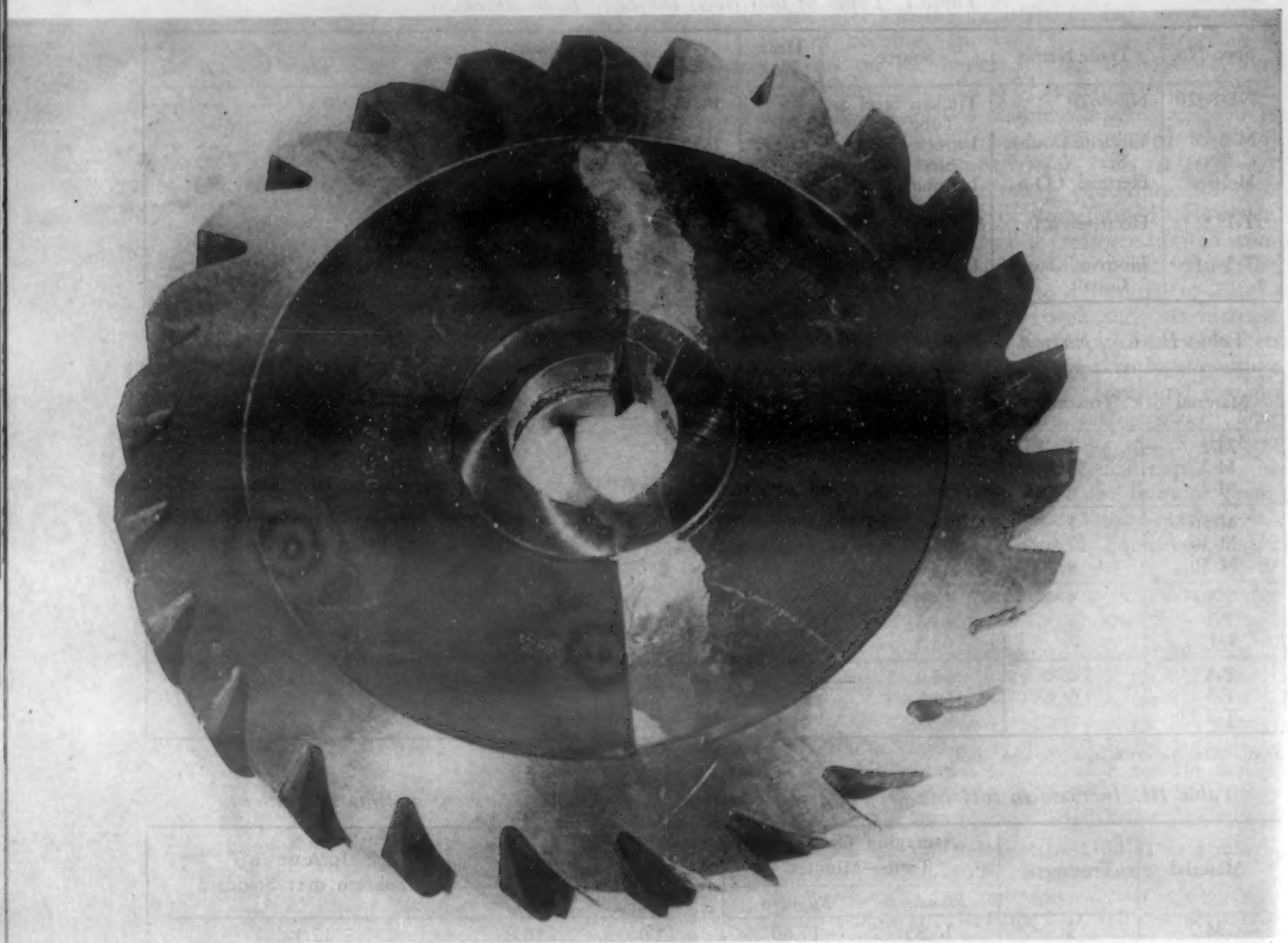
* Questionable—No explanation for high value.

Table III. Increase in tool life or productivity achieved by subzero treatment at time of hardening.

Material	Treatment	Averaging Operating Time—Minutes		P		% Increase in *P* Subzero over Standard
		Standard	*Subzero*	*Standard*	*Subzero*	
M-2	1	15.85	17.60	15.00	16.88	12.5
M-2	2	20.36	29.20	19.80	27.38	38.3
M-2	3	29.29	45.32	27.20	42.60	56.5
M-36	1	3.22	3.50	2.98	3.22	8.0
M-36	2	20.86	28.95	19.10	27.40	43.5
M-36	4	32.18	47.38	30.85	46.00	49.0
T-1	3	4.26	4.69	4.00	4.35	8.5
T-1	5	15.18	20.10	14.30	18.55	29.8
T-1	7	20.52	29.02	18.83	26.58	41.0
T-5	4	2.41	3.18	2.28	3.05	33.7
T-5	6	13.65	18.61	13.30	17.43	31.2
T-5	7	34.21	49.15	31.80	46.30	45.5

dangerous due to the tremendous strains that may be set up in an intricate tool. However, refrigeration following the quench may be accomplished with very small loss, if the cooling from the quenching temperature to the extreme cold is progressed very slowly to avoid shock. Many investigators believe that refrigeration actually relieves the quenching strains. At first blush this hardly seems feasible, but a later illustration will point out that this relief must *surely* take place.

It is important to note that the above-mentioned bits were not cooled below 100 F. during the quenching or cooling. Tools held at room temperature for more than five minutes have a distinct tendency toward austenite stabilization. This phenomena makes transformation more difficult, even at extreme low temperatures. It may also be noted that a tempering operation must always follow the refrigeration. Untempered martensite is always present after refrigeration. This structure is brittle and tends to chip unless tempered. However, the temper need not be more than 400 F. following refrigeration. A 400 F. temper before the refrigeration has been used with erratic results. It seems that the tempering at 400 F. has a tendency toward stabilization of the austenite, similar to that at room temperature. Nevertheless, some hardening departments are using the 400 F. temper instead of 1050 F.



A brazed 8¾-in. by 1¼-in. special formed milling cutter salvaged by cold treating after brazing.

Selecting Suitable Subzero Temperatures

There have been many arguments about the effectiveness of refrigeration on high speed steels with temperatures of—90 F. and above. Examination of Gordon and Cohen's paper "The Transformation of Retained Austenite in High Speed Steel at Subatmospheric Temperatures," A.S.M. *Transactions*, September, 1942, will convince the reader that little if any additional transformation takes place above —90 F. However, it may be possible that any refrigeration below—40 F. has some other structural effect on the steel. Investigations and tests conducted by the author on temperatures above—100 F. have not revealed any differences in structure or productivity of the tools tested. This may be interpreted as proving that the effect of refrigeration above—100 F. is not *enough* to produce desired results.

Appearance of the martensite in tools refrigerated at—100 F. or lower is somewhat different than that present in unrefrigerated material. Fig. 1 is a micro-

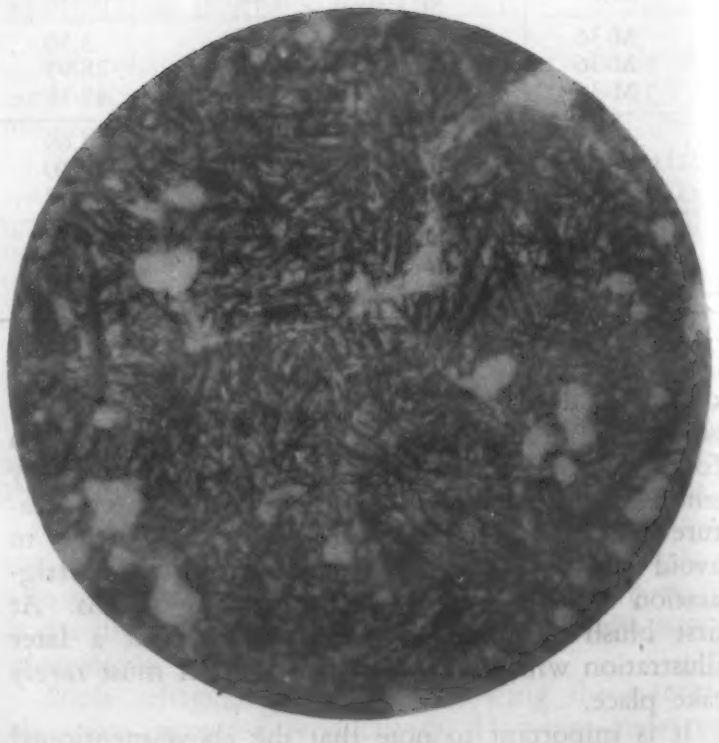


Fig. 1. Microstructure of steel M-2 given treatment No. 3 without refrigeration.

section of M-2 steel treated by treatment No. 3 without refrigeration. Fig. 2 is the same material and same treatment with refrigeration at—105 F. inserted between the tempers. Fig. 3 reveals the structures present in M-2 steel when treated according to treatment No. 2, and refrigerated between the tempers at—85 F. One can very readily see the difference between Figs. 1 and 2. The martensite in Fig. 1 is heavy and acicular. That present in Fig. 2 is fine and powdered. One might even say that Fig. 2 is austenitic, except that we know that this is not true, from size change tests and hardness. Fig. 3 shows a structure very similar to that of Fig. 1, proving that refrigeration at—85 F. has very little effect on the structure of this material.

Strain-Relief by Refrigeration

At this point it may be well to discuss the effect of refrigeration on tools that have been hardened and tempered, and allowed to stand for periods ranging from hours to months. In most cases better results have been obtained from these tools following refrigeration. However, in some cases no apparent change was noticed. For example, six twist drills from one supplier and six from another were subjected to refrigeration at—120 F. for 4 hr. The refrigeration was followed by a 2 hr. temper at 400 F.

These drills had produced an average of 3 to 5 pieces per grind before refrigeration. After refrigeration the drills from one supplier produced 30 to 45 pieces per grind and the drills from the other supplier revealed no change in productivity.

Reference has already been made to the possibility that refrigeration may actually relieve strain in the hardened steel. An example of this is in the relief of grinding cracks. Grinding cracks are one of the most frequent causes of tool failure. Some threading blades, whose average production was about 20 pieces per grind, had been very badly surface-cracked due to poor grinding. Feeling certain that it would be impossible to grind beyond the cracks, due to their tendency for progression, the blades were tossed into the freezing unit and held there for 5 hr. at—120 F. They were then tempered at 400 F. Strange as it may seem, grinding then eliminated the cracks altogether. This had never been accomplished before on this particular type of tool. Furthermore, the blades produced about 100 pieces per grind following the refrigeration treatment.

Some of the statements made in this article may seem anomalous. The best proof is to try out the process on your own tools. Expensive equipment is not necessary for testing. A freezing unit may be set up by adding methanol to dry ice in a suitable container. If this container is placed in another ice box it will attain a temperature of—100 F. or less.

As stated before, the process is by no means limited to carbon steels and high speed steels. It may be used with success on any ferrous material that can be hardened. It is believed that it may have some effect on austenitic steels such as 18-8 stainless and high manganese steels. It may be used on high nickel carburizing steels, where the case has a tendency to be austenitic, thus giving a "soft skin." The effect of the process on high-carbon, high-chromium tool steels is now under investigation, and preliminary results are very gratifying.

Refrigeration has also been used on nonferrous metals to relieve internal strains. In fact, the process has such a wide scope that it is believed the refrigeration unit will become as important in the future as the furnace for hardening operations.

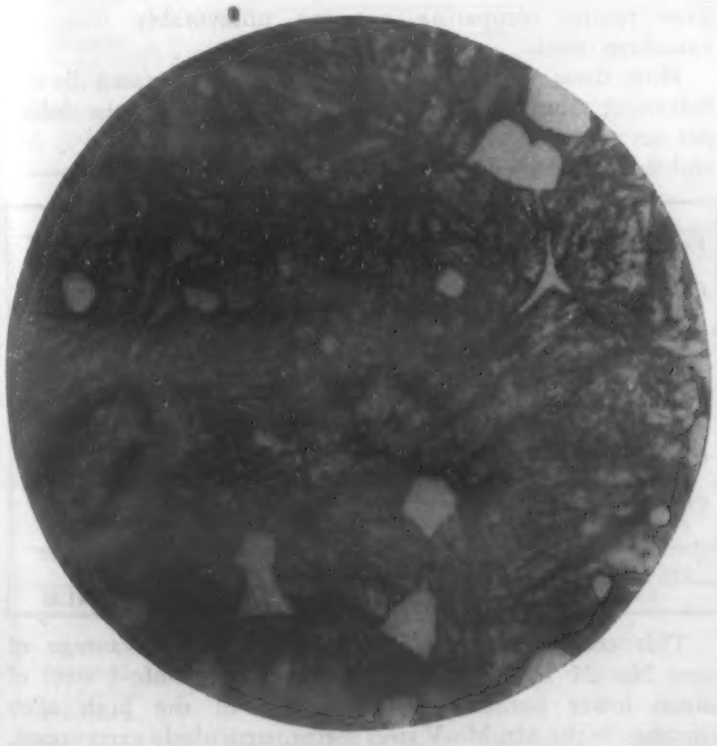


Fig. 2. Microstructure of steel M-2 treated by method No. 3, but refrigerated at—105 F. between tempers.

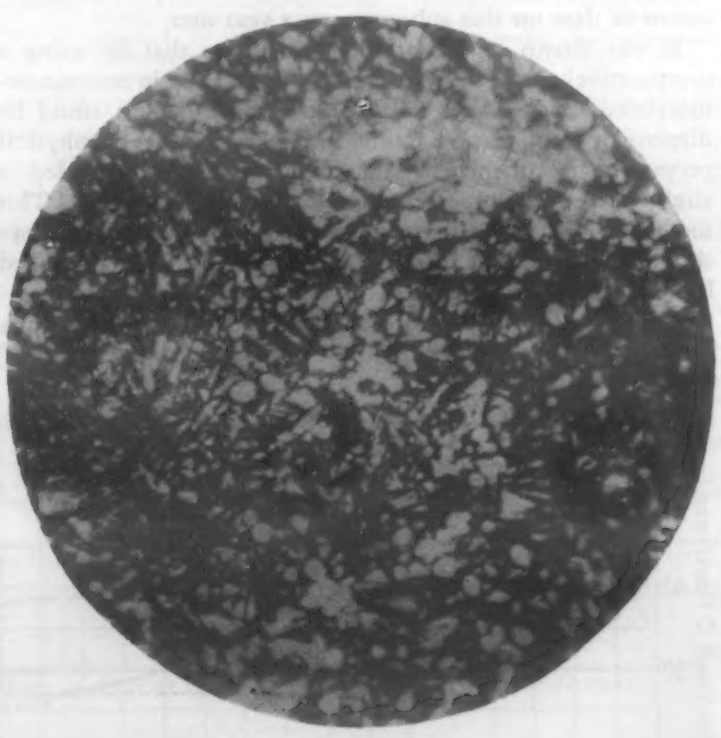


Fig. 3. Microstructure of steel M-2 treated by method No. 2 and refrigerated at—85 F. between tempers.

The Price for Being Sure

Instruments cost money. Every manufacturer who has purchased precise equipment for testing, inspection, or control knows that. Many a test engineer, looking at a seemingly simple device which doesn't appear to involve the use of large quantities of gold, platinum, or radium in its production, and then at the price — probably above that of a well-built, well-designed automobile—has sighed a heartfelt sigh.

One of the country's largest makers of aircraft instruments gives a few figures which should be enlightening. These instruments must perform perfectly under almost impossible conditions. A bomber may take off from a sandy airstrip in the desert, with air temperatures at 110 degrees and the temperature of exposed metal much higher — humidity only a few per cent — clouds of sand to abrade metal parts; yet an hour later the temperature may be far below zero, with ice forming on metal which had been too hot to touch. In the humid tropics mildew seems to attack everything. Radio parts must be specially treated with wax or other moisture-proofing material. But regardless of conditions the instruments *must* perform.

For radios for home use, about 10 per cent of the direct labor costs will go for inspection and testing. This would be high for most metal industries. However, when the radio is to be used for military or naval needs, or in commercial aviation, testing and inspection will account for from 50 to 75 per cent of all direct labor costs. This is the price paid for being sure.

The story is the same for most delicate and precise instruments. What the purchaser really buys is this painstaking testing and adjusting by experts, which is frequently the largest single item in the cost of the article — the price paid for being sure. —K. R.

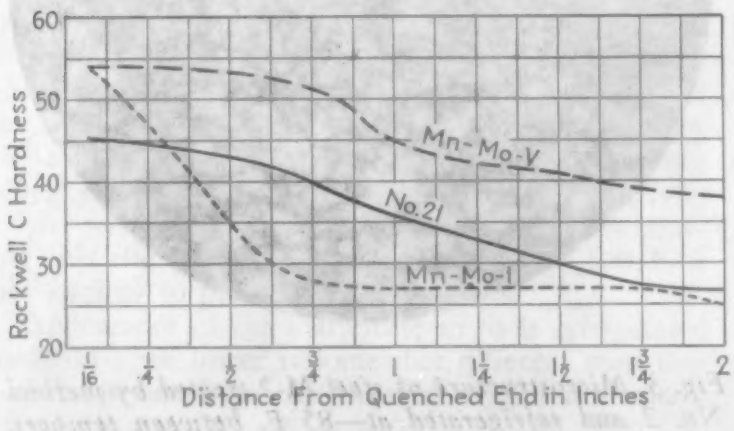
Letter to the Editor

Hardenability of Cast Steel

To the Editor: Mr. Briggs is mistaken in his statement on page 1415 of your June number that the articles on "Hardenability of Cast Steel—a Symposium" following his remarks are "the first to appear in the technical press regarding end-quench studies on cast steels". If he or you will refer to METALS AND ALLOYS for May, 1943, it will be found on pages 982 and 983 that the Symington-Gould Corp. were progressive enough to be interested in hardenability determinations on cast steel, and to encourage publication of data on this subject, over a year ago.

It was shown in the article referred to that by using a comparatively inexpensive titanium-boron alloy in manganese-molybdenum cast steel, most of the molybdenum could be dispensed with, at no sacrifice of hardenability or physical properties of quenched and drawn castings, provided a slightly lower tempering temperature were used. This method of saving molybdenum or other expensive alloys should be of interest in connection with the steels described by Mr. Kiper on page 1424 of that issue.

In the drawing submitted herewith are plotted the hardenability curves for his Mn-Mo-No. 1 and Mn-Mo-V



steels, together with the similar curve of the cast steel No. 21 in the May, 1943 article. The analyses of these steels compare as follows:

Steel	C.	Mn.	Si.	Mo.	V.	Ti.	B.
Mn-Mo-1	0.31	1.04	0.37	0.40	——	——	——
Mn-Mo-V	0.32	1.50	0.48	0.53	0.13	——	——
No. 21	0.28	1.66	0.53	0.18	——	0.021	0.001

The chart shows the same type of curve, indicating similar hardenability, for the vanadium and No. 21 steels, though the latter, having a lower carbon content, is naturally at a lower level of hardness. Both these steels have much higher manganese than Mn-Mo-1, which is a very significant factor in their greater hardenability. It is notable that the titanium-boron addition in No. 21, with much lower molybdenum, gave results comparing not too unfavorably with the vanadium steel.

How these steels compare in cost is illustrated by the following tabulation, showing the cost increment in dollars per net ton of steel for the alloy contents above 1.04% Mn and 0.18% Mo:

Steel No.	Mn-Mo-1	Mn-Mo-V	No. 21
Ferromanganese increase, lb. per ton	0	10	15
Cost per ton of steel ($0.0625 per lb.)	—	$0.62	$0.95
Molybdenum increase, lb. per ton	4.4	7	0
Cost per ton of steel ($0.80 per lb.)	$3.52	$5.60	—
Vanadium increase, lb. per ton	0	2.6	0
Cost per ton of steel ($2.70 per lb.)	—	$6.82	—
Carbortam (Ti and B), lb. per ton	0	0	6
Cost per ton of steel ($0.0825 per lb.)	—	—	$0.50
Total extra cost per ton	$3.52	$13.04	$1.45

This cost comparison shows clearly the advantage of steel No. 21 in economy, even over the Mn-Mo-1 steel of much lower hardenability. The use of the high alloy contents in the Mn-Mo-V steel seems particularly extravagant, in view of the hardenability data reported in the illustration, and the comparative effectiveness of Carbortam, molybdenum and vanadium. This steel must be made for some application where economy is of no importance.

Titanium Alloy Mfg. Co.
Niagara Falls, N. Y.

Geo. F. Comstock,
Chief Metallurgist.

NUMBER 58
September, 1944

Low Melting Alloys

	Part	Fusible Alloy	M.P. (F.)	Composition, %	Use
Alloys for Safety Devices	Boiler Plugs	Tin		Sn, sometimes small amounts of Pb	Bronze plugs filled with tin and screwed into boiler at lowest safe water level, to melt when level is reached.
	Sprinkler System Plugs	Woods metal or modification, 160 F. pattern	about 163 F.	50 Bi, 25 Pb, 12.5 Cd, 12.5 Sn	To release water spray when air temperature reaches prescribed point.
		200 F. pattern		52 Bi, 32 Pb, 16 Sn	Used in tropical climates or industrial applications where continued heat may cause the 160 F. alloy to creep below its fusing point.
		212 F. pattern		50 Bi, 31 Pb, 19 Sn	
		286 F. pattern		50 Bi, 50 Pb; or 56 Bi, 44 Pb	
		360 F. pattern		33-1/3 Pb, 66-2/3 Sn; or 37 Pb, 63 Sn	
	Chlorine Cylinder Plugs	Lipowitz metal	160 F.	50 Bi, 26-2/3 Pb, 13-1/3 Sn, 10 Cd	To prevent overheating of compressed gas.
	Some alloys, or slight modifications, used for releasing automatic fire doors, operation of automatic fire alarms, protection of electric water-heaters or oil burners, etc.				
Alloys for Solders	Standard 50-50 Solder			50 Pb, 50 Sn	Formerly the general purpose soft solder; now replaced for most work by low-tin emergency formulas. Tensile strength about 6400 p.s.i.
	S.T. Solders		above 580 F.	Pb + 1¼, 2½, 5 Ag	Wartime solders designed to save tin; tensile strength about 5000 p.s.i.
	Pewter Solder			50 Bi, 25 Sn, 25 Pb	For soldering pewter and similar low-melting alloys for which standard solders would not be suitable.
	Glass Solders	Woods metal	165 F.		May be used for glass-to-glass or metal-to-glass joints. Compositions with indium are especially useful in this field.
	Fusible alloys are also used for soldering parts subject to damage at higher temperatures, as wax-filled radio condensers, etc. Addition of a few per cent of indium increases wetting properties and lowers m.p.				
Alloys for Molds or Patterns	Patterns	Cerrobase	255 F.	58 Bi, 42 Pb	For permanent metal patterns, match plates, proof castings, etc. Cerrobase has no shrinkage upon cooling so that metal patterns can be made from a wood master pattern without allowing for double shrinkage.
		Cerrosafe	160 F.		
	Molds	Cerrobase	255 F.	58 Bi, 42 Pb	Metal, as Cu, electrodeposited on Cerrobase mold, which is then removed by melting out. Iron master model electrodeposited on Cerrobase negative, and molds for rubber, plastic, die casting, etc. formed from this.
		Cerrosafe	160 F.		
	Other low-melting alloys can be similarly used if complete absence of shrinkage is not required.				
Alloys for Tool Fabrication	Wood Pressing Dies	Cerromatrix	248 F.	48 Bi, 28.5 Pb, 14.5 Sn, 9 Sb	May be cast against a wood, etc., master carving, and other wood pieces pressed directly from this. Tensile strength about 13,000 p.s.i.
	Punches and Dies (Metalworking)	Cerromatrix	248 F.	48 Bi, 28.5 Pb, 14.5 Sn, 9 Sb	Punches, etc., located in punch plate and anchored by molten alloy. Dies for metal-forming where runs are short may be cast in this alloy. Repair of tools and dies.
	Magnetic Chucks	Cerromatrix	248 F.	48 Bi, 28.5 Pb, 14.5 Sn, 9 Sb	Highly diamagnetic, hence used to separate pole pieces on magnetic chucks.
Alloys for Metal Forming	Filler or Embedding Material	Woods metal (Cerrobend)	160 F.	50 Bi, 26.7 Pb, 10 Cd, 13.3 Sn	Metal tubes filled with Woods metal, bent, and fusible alloy melted out by hot water. Hollow silverware embossed by filling silver tube with alloy, swaging on the design, and melting out fusible metal. Irregular forms, as metal molding, embedded in fusible alloy for bending. Irregular objects embedded in fusible alloy to permit chucking in lathe, etc., for machining.
	Master for Profiling	Woods metal, etc.	160 F.	50 Bi, 26.7 Pb, 10 Cd, 13.3 Sn	A negative casting made from a wooden or plaster mold may be used for a guide in profiling machines.
Miscellaneous Alloys		Anatomical alloy	140 F.	53.5 Bi, 19 Sn, 17 Pb, 10.5 Hg	For embedding animal tissues.
		Rose's alloy	212 F.	50 Bi, 28 Pb, 22 Sn; or 46 Bi, 20 Pb, 34 Sn	Has comparatively high tensile strength—about 8000 p.s.i.
		Dental amalgam		Hg plus a finely divided alloy of Ag, Sn, Cu	Sets up hard after mixing. For filling dental cavities.
		Modified Lipowitz alloy	116 F.	18.3 indium added	Greater resistance to oxidation at high temperatures, and greatly lowered m.p.
			—76 F.	91.5 Hg. 8.5 Tl	Suggested for use in thermometers to read to —74 F.
Miscellaneous Uses	For metallixing of wood, as patterns; for tempering baths to be used at low temperatures; as a liquid seal for gas atmosphere furnaces, etc.				

Compiled by Kenneth Rose, Engineering Editor

Here's another "Double-Header" PROBLEM in CORROSION and ABRASION!

The business end of the modern dental drill illustrated above is, to most of us, just a symbol of unpleasant memories . . . but to its manufacturer it used to represent a double-barrelled production problem in corrosion and abrasion resistance!

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METALS and ALLOYS

Engineering File Facts

NUMBER 59
September, 1944

PROCESSES AND PROCEDURES
Cleaning

Cleaning Non-Ferrous Metal Parts

The fourth and last of the present series of "Engineering File Facts" on metal cleaning is this list of some of the common processes for cleaning non-ferrous metals and alloys. As with the previous "File Facts" in this series, no attempt has been made to list all the possible cleaning processes, nor to include all the cleaning or finishing methods of which these cleaning processes could be a part. This is intended to be a representative listing.

Job	Cycle of Cleaning Operations	Bath Characteristics	Remarks
Wrought and cast Al alloys (except die castings)	1. Soak 3-5 min. in caustic soda solution	2 oz. NaOH per gal. of water	Steel tanks are used for the alkali solutions; also washing machines may be used. [See Note 3.]
	2. Rinse in cold running water		
	3. Dry[1]		
Sheet Al parts requiring light etching	1. Dip in alkaline solution[2] (trisodium phosphate)	4-6 oz. $Na_3PO_4 \cdot 12H_2O$ per gal. of water at 180-200 F.	If a washing machine is used instead of a still tank, a slightly lower concentration may be used. [See Note 3]. A light, bright etch is obtained.
	2. Rinse in cold running water		
	3. Dry[1]		
Sheet Al parts requiring heavy etching	1. Soak in alkaline solution	Same bath as above	Acid dip (step 2) removes any smut deposited by soaking in trisodium phosphate. (This smut is not obtained if the work is merely dipped in trisodium phosphate, as above). A heated tank for the alkali and an acid proof tank are both needed.
	2. Dip in nitric acid bath	A 1-to-1 mixture of conc.[4] HNO_3 and water	
	3. Rinse in cold running water		
	4. Dry[1]		
Bright dipping cast Al alloy parts (containing Si, Cu and/or Fe)	1. Immerse in bright dip solution	3 gal. conc.[4] HNO_3, 1 gal. (48 to 52%) HF[5]	Because of the HF in the bright dip, lead-lined tanks protected with an organic coating are used.
	2. Rinse in cold running water		
	3. Dry[1]		
Pickling wrought Cu and Cu alloys (cartridge brass, leaded brasses, Cu, Ni, Ag, etc.	1. Soak in ferric sulphate[6] solution for ½-4 min.	85 lb. $Fe_2(SO_4)_3$ (anhydrous) per 100 gal. of water at 120-140 F.[7]	The tank for this solution must be acid resistant and capable of being heated. Mechanized or hand dipping equipment may be employed. This treatment will remove scale and stains, and the bath is non-fuming. Economical cleaning is possible over a fairly wide range of bath compositions.
	2. Rinse in cold running water		
	3. Dry[1]		
Pickling Si-Cu and Be-Cu alloys	1. Soak in ferric sulphate-acid bath for ½ to 30 min.	50-170 lb. $Fe_2(SO_4)_3$ per 100 gal. of solution, 32 lb. HF per 100 gal. of solution, at 140-160 F.	Lead, or lead lined, tanks protected by an organic coating are required.
	2. Rinse in cold running water		
	3. Dry[1]		
Bright dip used in conjunction with above pickling treatments	1. Soak in bright dip for ½ to 3 min.	85 lb. $Fe_2(SO_4)_3$ per 100 gal. solution plus one of following: 0.85-8.5 lb. per 100 gal. cream of tartar, 4.2-25 lb. per 100 gal. citric acid or glacial acetic acid	If a high luster as well as a clean surface is needed, this bright dip should follow immediately after one of the above pickling operations without any intervening rinsing. This is an economical, non-fuming bath and it is not highly corrosive.
	2. Rinse in cold running water		
	3. Dry[1]		
Cleaning brass (removing annealing scale prior to plating)	1. Immerse in red dip (sulphuric acid-sodium dichromate solution) for about 3 min.	8-10% (by vol.) H_2SO_4, 1-8 oz. per gal. $Na_2Cr_4O_7 \cdot 2H_2O$ at 160-200 F.	A lead-lined or ceramic tank that can be heated[8] is needed. Rinsing operations (especially steps 2 and 4) should be done in two-stage rinses (or a dip followed by a spray rinse). A ceramic, rubber-lined or pure Al tank may be used for the bright dip. This bath should be kept cool; one method of cooling is to use a ceramic tank surrounded by cool running water. For continuous operation this entire cleaning cycle can be mechanized, requiring unskilled labor to load and unload the conveyor or hangers. After final rinsing (step No. 6) the parts should be immersed in plating solution while still wet.
	2. Rinse in cold running water		
	3. Dip in bright dip for 5-30 sec.	1 gal. conc. H_2SO_4, 1 gal. tech. HNO_3, 1 fl. oz. conc. HCl, 1 gal. water	
	4. Rinse in cold running water		
	5. Dip in cyanide solution for at least 5 sec.	6-8 oz. NaCN per gal. of water	
	6. Rinse in cold running water		
	(7. Plate)		

(Continued on page 659)

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NUMBER 59 (Continued) CLEANING NON-FERROUS METAL PARTS

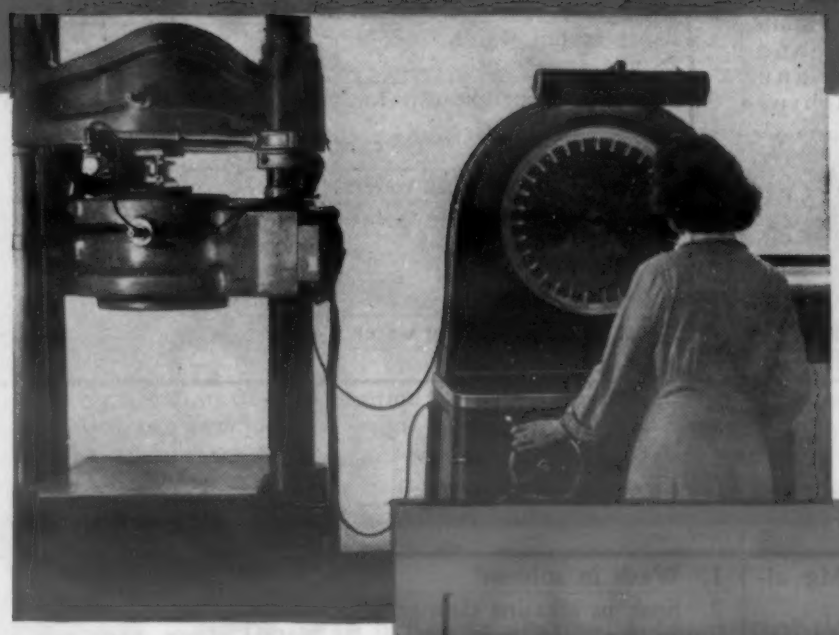
Job	Cycle of Cleaning Operations	Bath Characteristics	Remarks
Cleaning Cu and Cu alloy sheet stock (prior to spot and seam welding) and stampings and screw machine parts	1. Wash in solvent[9]		
	2. Soak in hot alkaline cleaner for ½-5 min.	5-8 oz. NaOH per gal. of water at 160-200 F.	
	3. Rinse in hot water		(Sometimes a cold water rinse is used in place of the hot water).
	4. Immerse in bright dip for 5-15 sec.	5 gal. conc. H_2SO_4, 1.5 gal. conc. HNO_3, 3.5 gal. water	
	5. Rinse in cold running water		
	6. Immerse in cyanide solution for 5-10 sec.	6-8 NaCN per gal. of water	The cyanide solution may be warmed (in this case the work is merely dipped in the cyanide solution); an exhaust hood is needed to remove poisonous fumes.
	7. Rinse in cold running water		
	8. Dry[1]		
Electro-cleaning of Cu and Cu alloys	Clean anodically at 20-40 amps. per sq. ft. for ½ to 3 min.	6 to 10 oz. cleaner[10] per gal. of water at 180-200 F.	For removing heavy deposits of dirt, grease, buffing compounds, etc., in a minimum of time the electro-cleaner is used; this may be combined with, or used in place of the alkaline cleaners in the above cleaning cycles. See "File Facts" No. 53.
Cleaning Mg alloy parts	1. Wash in solvent[9]		
	2. Soak in alkaline cleaner solution for 5-15 min.	3 oz. Na_2CO_3, 2 oz. NaOH, 1 oz. soap, water to make 1 gal. (solution should be kept boiling)	See "File Facts" No. 53. The efficiency of this cleaning operation is increased if the work is agitated or if a washing machine is used.
	3. Rinse in hot water	140-180 F.	
	4. Rinse in cold running water		
	5. Dry[1]		
Electro-cleaning Mg alloy parts	1. Same as above[9]		The added cost of electrical equipment for this cleaning operation is counterbalanced by reduction in processing time and the use of simpler cleaning equipment (no agitation of cleaner solution or work is needed).
	2. Clean parts cathodically at 10-20 amps. per sq. ft. (at 6 or more volts), 1-3 min.	4 oz. $Na_3PO_4 \cdot 12H_2O$, 4 oz. Na_2CO_3, water to make 1 gal. (solution should be kept as near the boiling point—over 180 F.—as possible)	
	Steps 3, 4 and 5 same as above		
Bright dip for Zn and Zn alloy parts (also for Cd)[11]	1. Immerse in chromic acid solution for 5-20 sec.	30-40 oz. CrO_3 per gal. of solution; 2-4 oz. Na_2SO_4 per gal. of solution	Pure aluminum, or glass-lined or ceramic tanks must be used for chromic acid solutions.
	2. Rinse in cold running water		A two stage rinse (a dip followed by a spray rinse) is good practice.
	3. Dry[1]		
Cleaning Zn alloy die casting prior to electroplating	1. Wash in solvent[9]		
	2. Dip in caustic solution for about 10 sec., or (2. Clean electrolytically in trisodium phosphate solution)	2-5 oz. NaOH per gal. of water at 160-180 F., or (6 oz. $Na_3PO_4 \cdot 12H_2O$ per gal. of water at 170-180 F.)	See "File Facts" No. 53 for remarks concerning alkaline and electro-cleaners.
	3. Rinse in cold running water		
	4. Dip in hydrochloric acid solution	3-5% (by vol.) conc. HCl	Use a lead-lined or ceramic (earthenware) tank for HCl solution.
	5. Rinse in cold running water		
	(6. Plate)		

1. Immerse work in hot water and allow to dry naturally (or dry in hardwood sawdust or in warm air blast after removing from hot water); or, if further chemical processing (such as electroplating, anodizing or passivating, etc.) is to follow immediately, drying is omitted and work-pieces given necessary treatment following final rinse. 2. If work-pieces are heavily coated with grease or lubricant, a degreasing (solvent or vapor degreasing) operation or pre-cleaning (rough cleaning in an alkaline solution similar to that used in step 1) should precede cleaning operation. 3. See "File Facts" No. 53 for type of equipment used for alkaline cleaning operations. 4. Concentrated CP nitric acid has a sp. gr. of 1.42; concentrated technical nitric acid usually a sp. gr. of 1.40. 5. Hydrofluoric acid. 6. A commercial form of 90% anhydrous ferric sulphate is sold, its use patented by Monsanto Chemical Co. 7. Slightly higher temperatures are used when cleaning Cu, bronzes and gilding metal. 8. It is not always necessary that the red dip solution be heated. 9. Solvent wash is only needed when work-pieces are heavily coated with grease, drawing compounds, etc. See "File Facts" No. 41 for discussion of solvent cleaning. 10. There are numerous commercial electro-cleaners on the market (see "File Facts" No. 41 for a brief discussion of these) and, in many of above listed cleaning solutions, proprietary cleaners may be used instead of chemical indicated. However, this chemical can be used, or it may serve to indicate type of cleaner that can be employed for cleaning. 11. Patents covering use of chromic acid dips for cadmium held by Udylite Corp., Detroit, Mich.

References: Plating and Finishing Guidebook, 1943, Metal Ind. Pub. Co., N. Y.; Metals Handbook, 1939 Ed., ASM. Cleveland, Ohio.

Compiled by Robert S. Burpo, Jr.

B&W Maintains Technical Control of Tubing Through Tensile Tests



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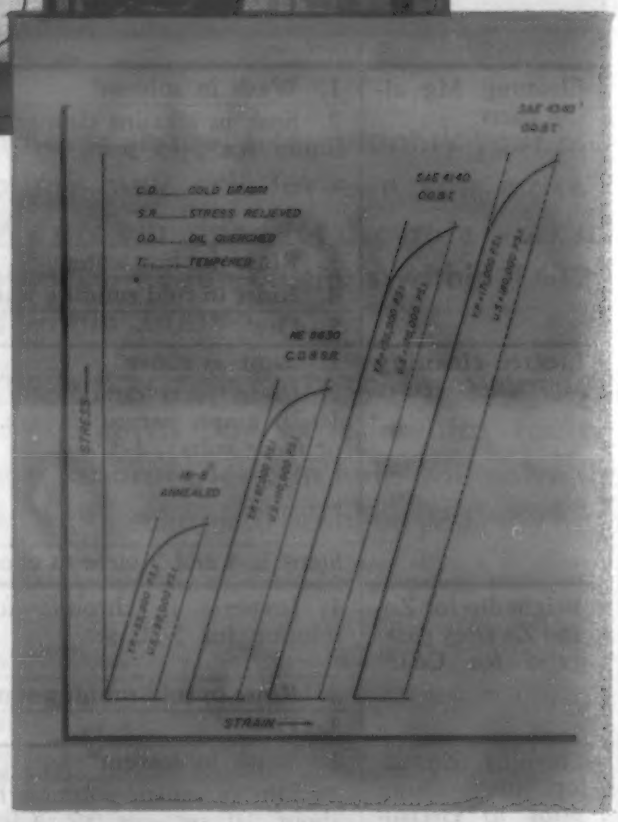

Reproduction of a recording of strain curves—showing tensile and yield point values for B&W tubular products under several conditions of heat treatment.

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TA-1306

METALS and ALLOYS

Engineering File Facts

NUMBER 60
September, 1944

MATERIALS AND DESIGN
Electrode Selection

Electrodes Suggested for Use With A.S.T.M. Pipe

SPECIFICATION NO. A-53-42
(Welded and Seamless Steel Pipe)
Chemical Analysis—Phosphorus max. % 0.06
for lap welded open hearth or electric
Chemical Analysis—Phosphorus max. % 0.11
for seamless or electric resistance

Tensile Requirements

Properties	Furnace Welded		Seamless or Electric Resistance Welded		Electrode Recommended
	Acid Bessemer	O.H. or Electric	Grade A	Grade B	A.W.S.
Ten. str., p.s.i., min.	50,000	45,000	48,000	60,000	E-6010
					E-6011
Yield pt., p.s.i., min.	30,000	25,000	30,000	35,000	E-6012
					E-6013
Elong. in 2 in., %, min.		30	none	given	E-6020
					E-6030

SPECIFICATION NO. A-72-39 (Wrought Iron Pipe)

Chemical Analysis—Manganese, 0.05% max.

Tensile Requirements

Tensile str., p.s.i., min.	40,000	Electrode recommended: A.W.S. E-6010
Yield point, p.s.i., min.	24,000	
Elongation in 8 in., %, min.	12	

SPECIFICATION NO. A-106-42T
(Seamless—High Temperature)

Chemical Analysis

Element, Per Cent	Welded Open Hearth	Seamless	
		Grade A	Grade B Si Killed
C, max.		0.25	0.35[a]
Mn, max.	0.30—0.60	0.30—0.90	0.35—1.00
P, max.	0.045	0.04[a]	0.04[a]
S, max.	0.06	0.06	0.06
Si, min.			0.10

(a) When acid Bessemer steel is furnished for Grades A and B seamless pipe, the phosphorus content shall be 0.11% max., and carbon shall be 0.25% max.

Tensile Requirements

Properties	Welded Open Hearth	Seamless		Electrode Recommended
		Grade A	Grade B Si Killed	A.W.S.
Ten. str., p.s.i., min.	45,000	48,000	60,000	E-6010
				E-6011
Yield str., p.s.i., min.	25,000	30,000	35,000	E-6012
				E-6013
Elong. in 2 in., %, min.	22	——	——	E-6020
				E-6030

SPECIFICATION NO. A-158-42T
(Seamless—Elevated Temperature)

Tensile Requirements

Properties	Ferritic		Austenitic		Electrode Recommended
Ten. str., p.s.i., min.	60,000		75,000		For the *austenitic* steels use stainless type electrode.
Yield str., p.s.i., min.	30,000		36,000		
Elong. in 2 in., %, min.	Longitudinal	Transverse	Longitudinal	Transverse	For ferritic steels 4% to 6% Cr use 4% to 6% Cr or type 25-20 electrode.
5/16 (0.3125)	30.00	20.00	50.00	40.00	
9/32 (0.281)	28.50	19.00	47.50	38.00	
1/4 (0.250)	27.00	18.00	45.00	36.00	
7/32 (0.2187)	25.50	——	42.50	——	
3/16 (0.1875)	24.00	——	40.00	——	For chrome-moly use chrome-moly electrode if available. Otherwise use type 25-20 electrode.
5/32 (0.156)	22.50	——	37.50	——	
1/8 (0.125)	21.00	——	35.00	——	
3/32 (0.0937)	19.50	——	32.50	——	
1/16 (0.0625)	18.00	——	30.00	——	

SPECIFICATION NO. A-206-42T
(Seamless—Elevated Temperature)

Chemical Analysis

Element	Per Cent
Carbon	0.10—0.20
Manganese	0.30—0.60
Phosphorus, max.	0.04
Sulphur, max.	0.05
Silicon	10.00—50.00
Molybdenum	0.45—0.65

Grade: carbon molybdenum

Tensile Requirements

Properties	Longitudinal	Transverse	Electrode Recommended—A.W.S.
Ten. str., p.s.i., min.	55,000		E-7010 or equivalent.
Yield str., p.s.i., min.	30,000		
Elong. in 2 in., %, min.	22	14	

Compiled by W. J. Conley, Consulting Engineer,
The Lincoln Electric Co., Cleveland, Ohio

WHENEVER YOU WELD STAINLESS OR FERRITIC ALLOY STEELS

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2. **Heat treatment specifications of the welded structure for the more important Stainless and Alloy grades.**

3. **Identifying grade information.**

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METALLURGICAL ENGINEERING

shop notes

Test Pit for Rotating Parts

by Albert A. Criqui,
Buffalo Forge Co.

The large vacuum test pit in the Research Laboratory of the Buffalo Forge Co., Buffalo, is a good example of what is being done to study stresses and improve the quality of high speed rotating machinery. The pit—so termed because

the shell is set in concrete below floor level—is 6 ft. in diam. by 4 ft. deep, made of heavy, reinforced construction to withstand absolute vacuum. While it was designed along the lines of the General Electric device for testing turbo-supercharger impellers and capable of operating at 60,000 r.p.m., it will generally accommodate larger fans at lower speeds.

The impeller to be tested is hung by a slender shaft from a small air turbine mounted on the cover. A vacuum pump exhausts the air from the drum so that it takes practically no horsepower to spin the fan. The pressure within the drum may reach as low as 200 microns of vacuum (.00787 in. of mercury absolute as compared to standard atmospheric pressure of 29.92 in. of mercury). Hence the power to drive the fan (exclusive of the turbine friction) is about 1/4000 of the power under normal conditions.

The acceleration must be gradual, the speed being under the constant control of the operator by an air valve and air brake. To keep the speed indicating device from absorbing power at the higher speeds, an electronic frequency meter is used, a direct reading dial type instrument with suitable amplification.

Several purposes are served by such a test pit. To insure the safety of operation of cast or fabricated fans, the fan may be run at sufficient overspeed to permit calculation of the factor of safety. On new design the impeller may be tested to destruction in order to determine the weakest section or some unpredictable condition. There is supplied a laminated shield within the main shell so that the force caused by rupture will spend itself against this shield and not seriously harm the shell which maintains the vacuum.

A check on fan balance can be made on high speed impellers that might otherwise be impossible, except at final installation. Thus, a fan that would require 1000 h.p. to drive normally can be operated in a vacuum of 200 microns of mercury by ¼ air h.p. Then there is an opportunity to study stress conditions while the unit is in operation. A glass aperture in the cover of the pit permits visibility of the impeller by stroboscopic light. Also through the use of strain gages in circuit with a cathode ray oscilloscope, stresses and vibration may be visualized and measured.

Automatic "Watchman" for Drilling

by Stanley Koselak,
Bendix Aviation Corp.

To prevent broken drills and damage to castings, we devised "trip bars" to make an automatic check for perfect balance in a casting before the drills reach the part to be drilled. These bars are designed to precede the downward path of drills, and are connected to a switch that automatically stops and reverses drills if a casting is found to be out of balance.

The device is being installed on numerous machines at the South Bend, Ind. plant of Bendix Products.

[The author, a drill press operator at the South Bend plant of Bendix, received $584 as a war production suggestion award for this idea.—Editor.]

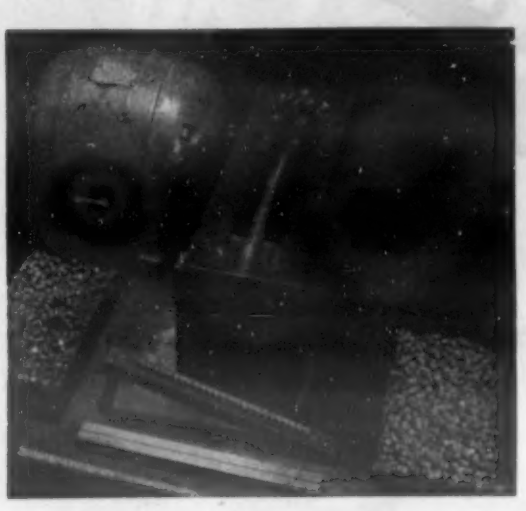
Guards to prevent weld spatter from burning the cable and the spring in the holder for arc welding doubled the life of the holders. The guards are sheet metal formed around three sides of these critical parts and serving as shields. Because of springiness in the sheet steel and close fit, they clamp on without extra fastening devices.

—C. J. Smith,
Parish Pressed Steel Co.

Slotting Phenolic Parts With Saw

by L. Chamberlain,
Westinghouse Electric & Mfg. Co.

It is necessary to cut slots in phenolic coil forms that are used in an apparatus of a confidential nature. Equipment consists of a circular saw mounted in a suitable fixture and a holder for retaining some two dozen units of work during the operation. Production with this equipment has been stepped up 300% over the former method.



The material of the phenolic coil form is called "Resinox." Before these were slotted with a circular saw, the design was different—a hole having been drilled through the parts.

In the accompanying photograph can be seen the saw assembly box, with the circular saw barely visible at the rear of a slot. Immediately in front is the holder or hand fixture, with quota of parts, ready to be inverted over the saw runway. Unslotted parts appear in the pan at the left; slotted, in the pan at the right. The author is connected with the Mansfield, Ohio plant.

Novel Design Electrical Junction Boxes

by Harry Cramer,
Glenn L. Martin Co.

Several novel design ideas are incorporated in a new plastic electric junction box for airplanes. Principles embodied herein might well be applied to a host of other engineering gadgets. This plastic box is lighter and easier to assemble than the standard aluminum alloy boxes.

It reverses present practice by using a flat plate as the main section to which installations and wiring are attached, and a molded cover of Plexiglass or other transparent plastic. In the conventional box all installations are made in the box proper where they are far less accessible during assembly and maintenance than on the new flat surface.

Another feature is that the base plate is sensitized, with a photographic reproduction of the wire flow diagram. This simplifies drilling, assembly and wiring in the factory and provides a permanent record for field service men.

Either a metal or laminated plastic base can be used, depending on whether ground studs are needed in the assembly. With the old type box the cover had to be removed and replaced 23 times for inspections between original installation and the turning of the airplane over to ground test. Additional removals take place in the field. The transparent cover eliminates need for removal for mere inspection.

The manufacture of the cover requires only a single, low cost, cavity mold. The forming is done with air from a flat sheet heated to 380 F. In an airplane similar to the PBM-3 Mariner about 100 junction boxes are used in its electrical systems.

Here is a method for removing carbide tips from tool shanks that saves at least 45% of the remachining of shanks and gives 100% more life to the shank. Heat a furnace up to 2000 F. and put shanks in the furnace, leaving in 2 or 3 min. Take out and knock off the tip. Savings at an International Harvester plant, equivalent to 5371 man hours, were affected.

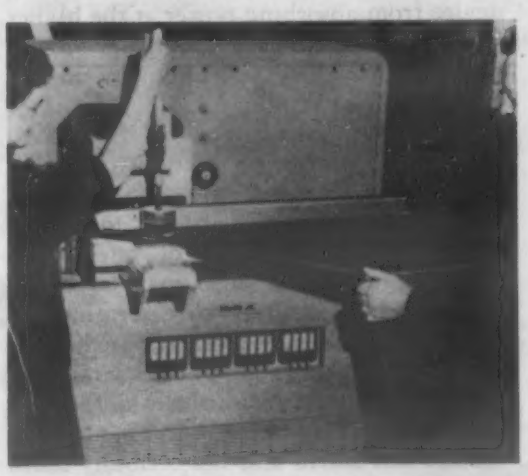
—William C. Loew,
International Harvester Co.

Silver Brazing on Life Rafts

by H. A. Folgner,
Handy & Harman

What had been a serious bottleneck in the construction of metal life rafts at the plant of the Weber Showcase Co., Los Angeles, has now become the fastest part of the assembly. There are 48 manganese bronze drain flanges joined to the SAE 1020 steel sections from which the raft is made. Bronze welding these flanges in place was slow, taking 7 to 12 min. per flange.

Using the low temperature silver brazing alloy, "Easy-Flo," and induction



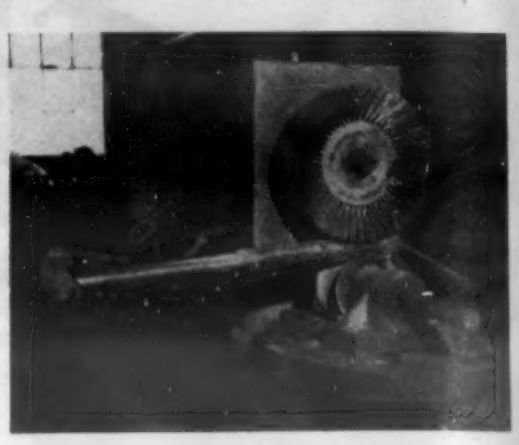
heating, the joining time was reduced to 51 sec. per flange. After proper cleaning and fluxing, a washer of Easy-Flo 0.003 in. thick is preplaced between the flange and raft section. Leak-tight joints are formed that hold firmly in place through every drop test the raft must meet.

Reclaiming Old Pipe by Brushing

by G. O. Rowland,
Osborn Mfg. Co.

Because of the scarcity of steel in many forms it is often possible to reclaim worn second hand material, such as pipe that has been covered by rust and scale. One of the most economical and quickest ways of restoring pipe surfaces to "as good as new" is by rotating wire brushing wheels of the proper size and gage of wire.

Thus the Builders Structural Steel Co., Cleveland, conditions many kinds of sec-



ond hand pipe for industrial re-use. Depending on the size of pipe being cleaned, combinations of two, three, four or more wire brushing wheels with disc center are mounted on a spindle powered by a stationary electric motor. The wire wheels, of about No. 33 gage wire, revolve at a speed of 1800 r.p.m.

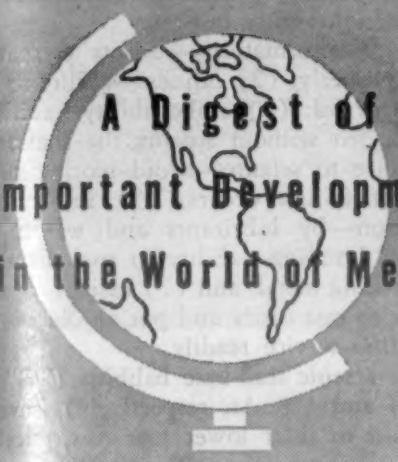
Pipe is inserted between a roller mounted on the bed of the unit. Then the operator moves the pipe back and forth about 10 to 12 in. at a time under the revolving brushes, rotating the work slowly to clean all sides. The roller fixture, which can be replaced with a size roller to fit the diameter of the pipe being brushed, is also adjustable by turning a hand crank on the side of the fixture so that required pressure can be applied. A long length of pipe is handled by placing it on adjustable roller dollies.

The method is at least 10 times faster than hand methods and is claimed much more effective than previous machine methods.

We have devised a small fixture to stamp identification marks upon assembled units of small instrument motors. The press, which replaces hand methods, saves time and gives perfect imprints. A standard high viscosity printing ink is used. A wooden frame with tracks to fit the motor is placed on an incline. The motor is rolled slowly along the track. Rubber type is placed on a hinged pellet, lying flat between the tracks, printing on the motor housing as it rolls over it. The pallet can be folded back 180° to an inking surface where it is easily re-inked.

—P. S. Boucher,
General Electric Co.

Metallurgical Engineering Digest



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1 Metal Production

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Steel Mill Bearings

Condensed from "Iron and Steel Engineer"

Problems connected with steel mill bearings are roughly divided into two classes. One involves design and construction, the other operation and maintenance. Under number one, probably the most important problem facing the designer and construction engineer is which alloys, other than tin-base, possess physical characteristics equal to the tin-base babbitts and are, therefore, suitable for steel mill use.

With the conventional 100-yr.-old babbitt (89 Sn, 7.5 Sb, 3.5% Cu) available for all those years, and the designer little limited with regard to size and weight of construction, bearing dimensions were adjusted through the years to meet operating conditions.

It would seem on the face of it that lead-base bearing alloys are quite the equal and, in some cases, possibly superior to tin-base bearing alloys, but as a matter of practical experience this has not proved to be the case, due to the measurement of these properties only at room temperature.

The properties of the various accepted alloys should be measured over a range of temperatures wide enough to include the highest temperature at which bearings could normally be employed.

As none of the conventional lead-base alloys containing various amounts of tin and antimony have properties reasonably close to those of the tin-base bearing alloys over a range of temperature, two new alloys developed by the company with which the writer is connected are described—known as "G" and "S" babbitts. They are essentially lead-base, containing antimony and arsenic, with a tin content of 1% or less.

Alloy "G" retains its high hardness at elevated temperature while alloy "S" has somewhat greater elongation, desirable in certain forming operations. Both have been used in steel mill bearings for the past two yrs.—in all theatres of war, replacing successfully more tin than any other conventional alloy.

The second part of bearing problems, as already stated, involves operation and maintenance. To operate successfully, a bearing alloy must possess:

(1) Conformability—ability to seat the shaft properly; (2) oiliness—ability to hold a film of oil; (3) embedability—ability to absorb grit without scoring the shaft; (4) resistance to seizure—avoid scoring of the shaft if failure occurs; (5) resistance to corrosion—by lubricants and water; (6) ease of bonding—ability to stick firmly to the backing metal; and (7) ease of repair—ability to cast easily and put an old bearing back into service readily.

The arsenic lead-base babbitts ("G" and "S", 3 and 1% As, respectively) have, in addition to their lower first cost, excellent frictional properties. Their oiliness, conformability, embedability, resistance to seizure, as well as their resistance to corrosion, are equal to the tin-base babbitts—now proven by actual trial.

—H. L. Smith. *Iron & Steel Engr.*, Vol. 21, June 1944, pp. 64-65.

Casting Metal Rolling Slabs

Condensed from "Metal Industry"

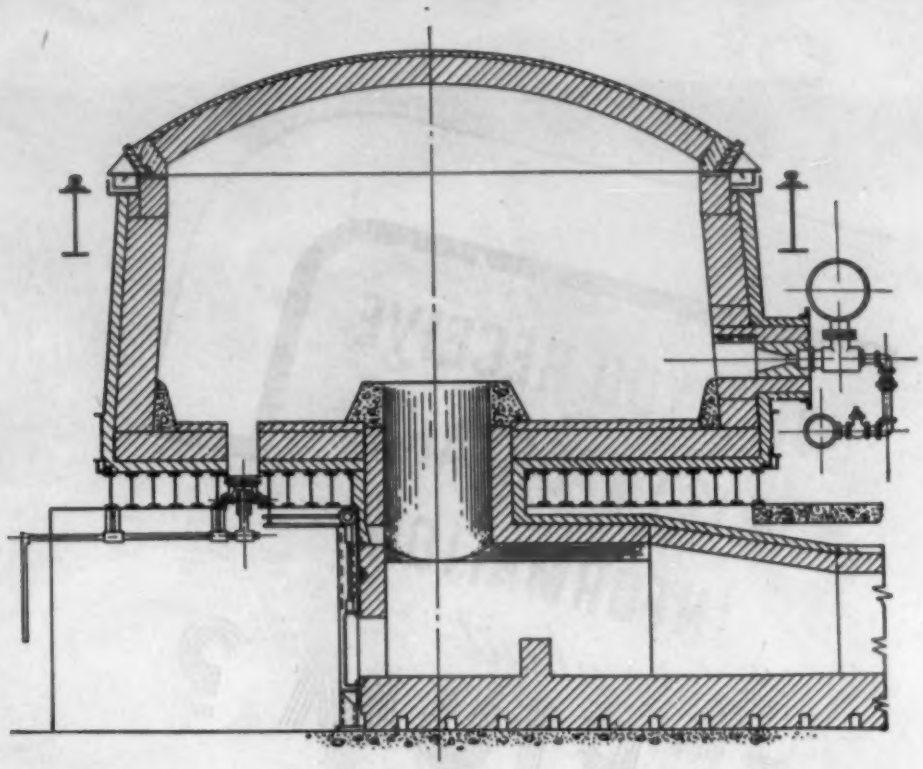
A heated frame, forming the walls of the Erichsen mold, copes with the shrinkage of pure aluminum, the light metal alloys, zinc and zinc-base alloys. Solidification is controlled so that it first reaches the surface of the metal over a circular area around the middle of the slab, spreading to the sides.

The upper surface of rolling slabs of pure (99.5%) aluminum made by this method was flat and smooth. No solidification from the sides was present, and the slabs were free from the usual types of porosity. Similar satisfactory results were obtained with zinc, zinc-alloys, brass, deoxidized copper and heavy metal alloys. For heavy metal slabs, a solid iron frame is used.

These cooled, flat molds may be used for either square or rectangular slabs. The thickness of the slab must not exceed a certain maximum value, but the dimensions of the bottom surface are not limited. Frames of any size can be attached to one cooling plate. Round slabs have been found suitable in the production of copper and brass wire.

For light metals, zinc and zinc alloys, the mold is inclined at an angle of 45°. Pouring is slow until the bottom and one

7 OPERATING ADVANTAGES • SALEM CIRCULAR SOAKING PIT



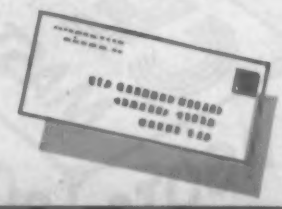
Sectional view of a Salem 20' diameter Circular Ingot Heating Furnace.

As Demonstrated in Scores of Installations in America's Mills

1. **Uniform temperature through the use of a multiplicity of small burners evenly spaced around the furnace wall.**
2. **Constant furnace atmosphere by means of an automatic fuel-air ratio control.**
3. **Maximum rate of heat transfer without injury to the surface of the ingots. The products of combustion whirl rapidly around the furnace, transferring heat to the ingots, and diluting the extremely hot gases which form at the burner ports. The gases exhaust through a center flue in the furnace bottom.**
4. **Any fuel can be adapted on either a continuous or intermittent basis.**
5. **Accurate control and uniformity of heat distribution permit most exacting heat treating practices.**
6. **Minimum scale loss assured by accurate temperature control and automatic atmosphere control.**
7. **Furnace can be cooled quickly or brought up to proper temperature fast because of the relatively small amount of brick in the design.**

One superintendent who has used a 20' Salem Circular Soaking Pit for more than six years says—"I like the Salem Pit because our records prove we save substantially on each ton of steel prepared in the Salem Pit."

Salem can show you how to cut conditioning costs . . . Prompt attention to your inquiry.



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side are filled. Then it is speeded up and the mold gradually tilted back to the horizontal. Pouring should be uninterrupted. The metal is skimmed at the completion of the pouring and again in one or two min.

Copper and copper alloys can be poured either into tilted or horizontal molds. After skimming, the metal is covered with a protective material. In a patented procedure, the metal is skimmed in the ladle and the protective covering material is poured with the metal. The covering material cannot be used with refined copper or nickel.

With slabs cast in flat cooled molds, loss due to the removal of the upper end of the slab is avoided. No preliminary milling is required. The slabs can be hot-rolled in the "as-cast" condition and rolled without any intermediate milling. The sheet obtained has excellent surface quality. Scrap losses are low.

As the slabs are free from crystals oriented in different directions, they do not crack when rolled. Capacity to deformation of trans-crystallized crystals is excellent.

—F. Erichsen, *Metal Ind.*, Vol. 64, Apr. 14, 1944, pp. 232-233.

Roasting Mixed Copper Ores

Condensed from "Mining Magazine"

Ores containing a small proportion of iron and copper pyrites can either be smelted for the concentration of matte or alternatively roasted in preparation for wet extraction. Attempts have been made to wash out the sulphide copper content by leaching, but copper did not appear to be sufficiently soluble unless a large excess of acid was used.

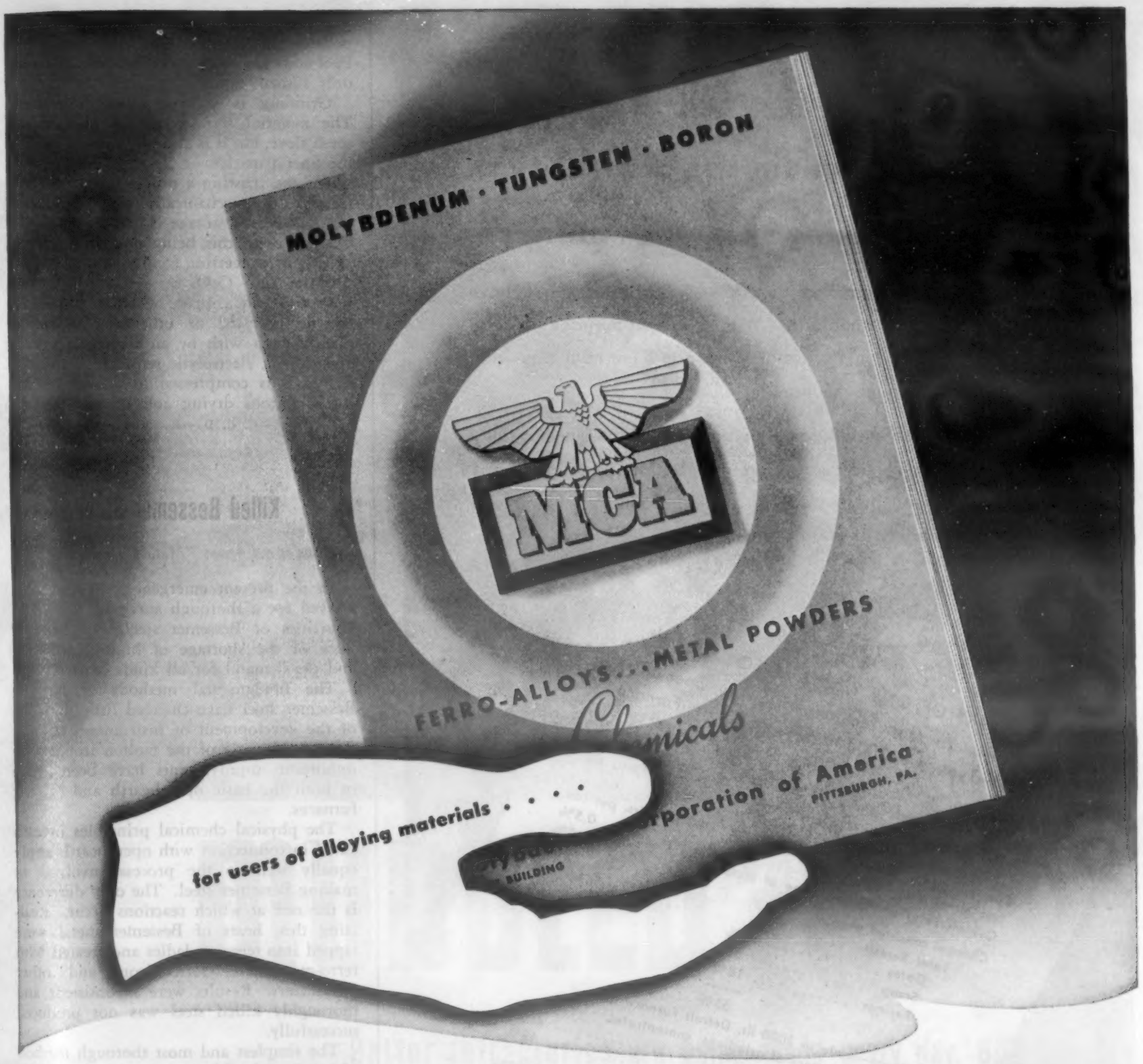
A different state of affairs exists where sulphide can be roasted to a soluble condition, since solubility may be attained without addition of acid. There is no point in roasting the carbonate copper ores, as is done with calamite or other zinc carbonate ores, since solubility is not improved.

When pyrites are heated around 502 F. part of the sulphur is evolved and sulphate of iron formed is converted into $Fe_2(SO_4)_3$. On raising temperature to 986 F. practically the whole compound is converted to ferric oxide.

With copper present, sulphate formation begins at 698 F., and this continues rapidly at 1112 F., but at about 1407 F. copper sulphate is converted to $2\,CuO \cdot SO_3$, which at 1299.2 F. forms CuO. The intermediate oxide, Cu_2O is undesirable, since when decomposed by H_2SO_4 it is partly resolved into CuO and metallic copper.

Although CuO dissolves in acid, the finely divided copper is in condition for precipitation and it is here that it is so detrimental where silver is also present in the ore. Therefore, efforts are made to control the roasting so as to produce CuO alone and when Cu_2O is revealed the material is returned for further roasting so that more oxygen is absorbed.

By means of judicious mixing of the material, it is possible to render the whole of the contained copper into soluble condition whereby, instead of roasting being limited to ores with a small proportion of



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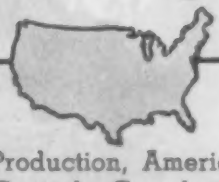

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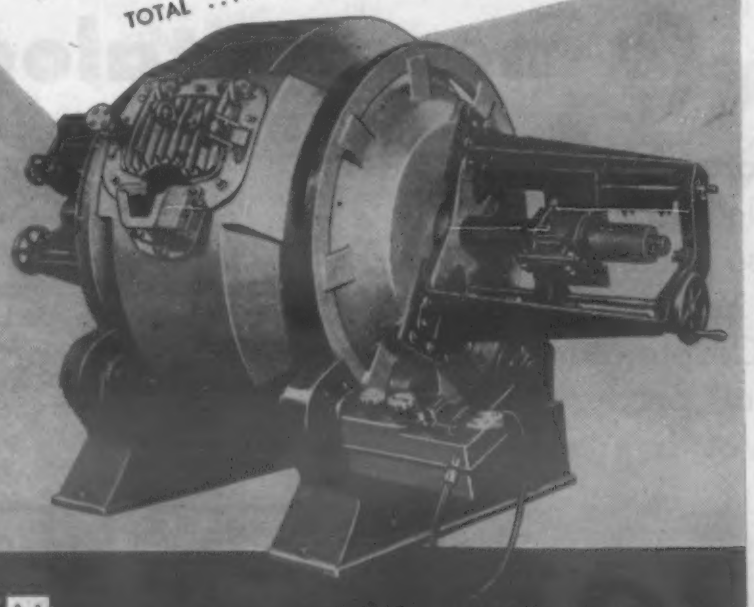
This summary of a full year's operation helps explain the popularity of Detroit Rocking Electric Furnaces

Records of their performance reveal why Detroit Furnaces have steadily increased in popularity. With a Detroit Furnace you can get 8 ferrous or 16 non ferrous heats in one eight-hour day—and with a minimum amount of labor.

You can get precise metallurgical control and thus highest quality results. Versatile, flexible and fast, the Detroit Rocking Electric Furnace has proven itself the most efficient Foundry melting unit for the widest variety of metals and alloys.

SUMMARY OF ONE YEAR'S PERFORMANCE
Of Midwestern Manufacturer of Steam Specialties
Using 4—Type AA—1000 lb. Detroit Electric Furnaces

Metal Melted	9,624,625 lbs.
No. of heats melted	12,049 heats
Electrodes used	17,960 lbs.
3.75 lbs. electrodes per ton of metal.	
Power Used	280 Kw. Hrs. per ton
Net Metal Loss	0.5%
Overall Plant yearly shrinkage of metal	1.40%
Charges consisted of:	
Total Remelt	32%
Gates	5%
Scrap	18%
Borings	
	55%
Ingot—made in 2000 lb. Detroit Furnace from	
Furnace charges of grindings, concentrates, turnings and scrap	27%
Purchased new metals	18%
TOTAL	100%



There is a correct size Detroit Furnace to meet all requirements from the 10 lb. laboratory size up to 8,000 lbs. molten metal capacity.

DETROIT ELECTRIC FURNACE DIVISION
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pyrites or sulphides, those containing carbonates and hydrates can be incorporated. Fuel costs are of primary importance where only a small amount of copper exists.

Grinding is also of great importance. The material should pass through a 32-mesh sieve, but it is also desirable to remove the finer particles.

For the roasting a muffle furnace is preferred to the mechanically operated roasting hearth. One advantage is that in the muffle CO is absent, this being one of the worst agents for converting freshly formed copper sulphate into CuO.

Precipitated copper, whether impurities are incorporated or otherwise, is conveniently dealt with by an improved system of applying electrolytic refining, as the soft red mass is compressed to anodes instead the circuitous drying and melting system.

—C. C. Downie. *Mining Mag.*, Vol. 70, May 1944, pp. 276-279.

Killed Bessemer Steel

Condensed from "Metals Technology"

In the present emergency, the time has arrived for a thorough survey of the characteristics of Bessemer steel, especially in view of the shortage of high-grade scrap and the demand for all kinds of steel.

The fundamental methods of making Bessemer steel have changed little, in spite of the development of instruments to control the blowing of the molten iron, while important improvements have been made in both the basic open-hearth and electric furnaces.

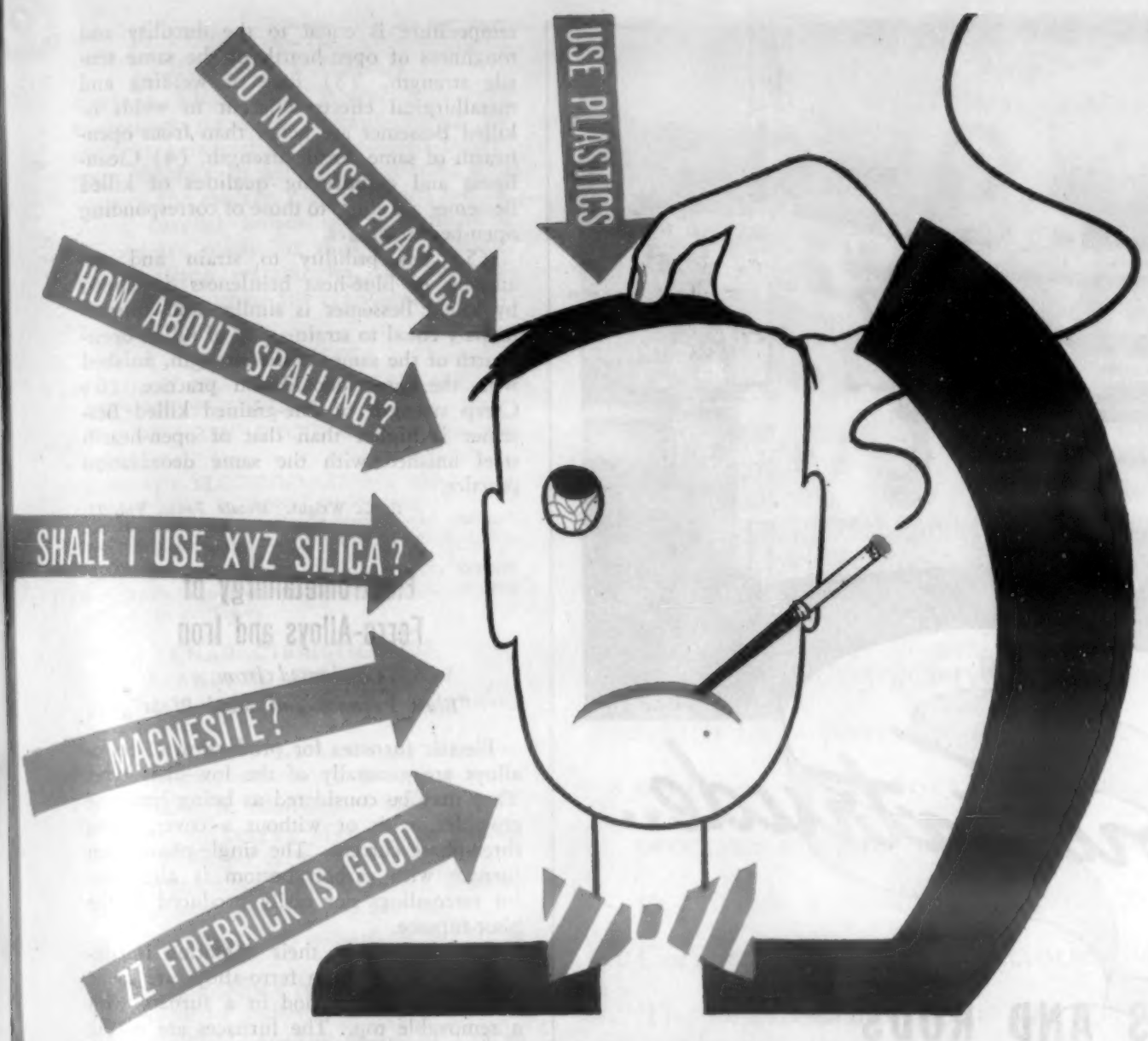
The physical chemical principles investigated in connection with open-hearth apply equally well to the process involved in making Bessemer steel. The only difference is the rate at which reactions occur. Realizing this, heats of Bessemer metal were tapped into teeming ladles and treated with ferro-manganese, ferrosilicon, and other deoxidizers. Results were inconsistent and thoroughly killed steel was not produced successfully.

The simplest and most thorough method of treating the blown converter bath with carbon is to add hot metal, which contains about 4% carbon as well as magnesium and silicon. The action of such additions to fully blown Bessemer heats gave a thorough preliminary deoxidation.

To Bessemer blows were added proper amounts of hot metal as converter additions. Steel was then poured into the teeming ladle and treated with the required amounts of ferromanganese, ferrosilicon and aluminum to deoxidize the blocked heat. Bessemer heats so treated were found to be thoroughly killed and of good forging quality. They could be teemed into regular hot-top molds, rolled into tube rounds and satisfactory seamless tubes.

It was found that thoroughly deoxidized Bessemer heats melted with this practice were fundamentally different from unoxidized Bessemer steel. Results of tests showed that: (1) The yield strength and fatigue properties of killed Bessemer steel are superior to those of open-hearth steel of the same tensile strength.

(2) Ductility and toughness of killed Bessemer steel both at room and sub-zero



MUDDLED?

Better refractories are being made every day, BUT the selection of refractories for most high temperature furnaces is essentially a compromise. No one type or brand of refractory will excel in all of the essential chemical and physical properties. Get 'confusion relief' by drawing on our experience of 80 years in trouble shooting refractory problems. A Taylor field engineer will be glad to go into a huddle and eliminate your muddle.

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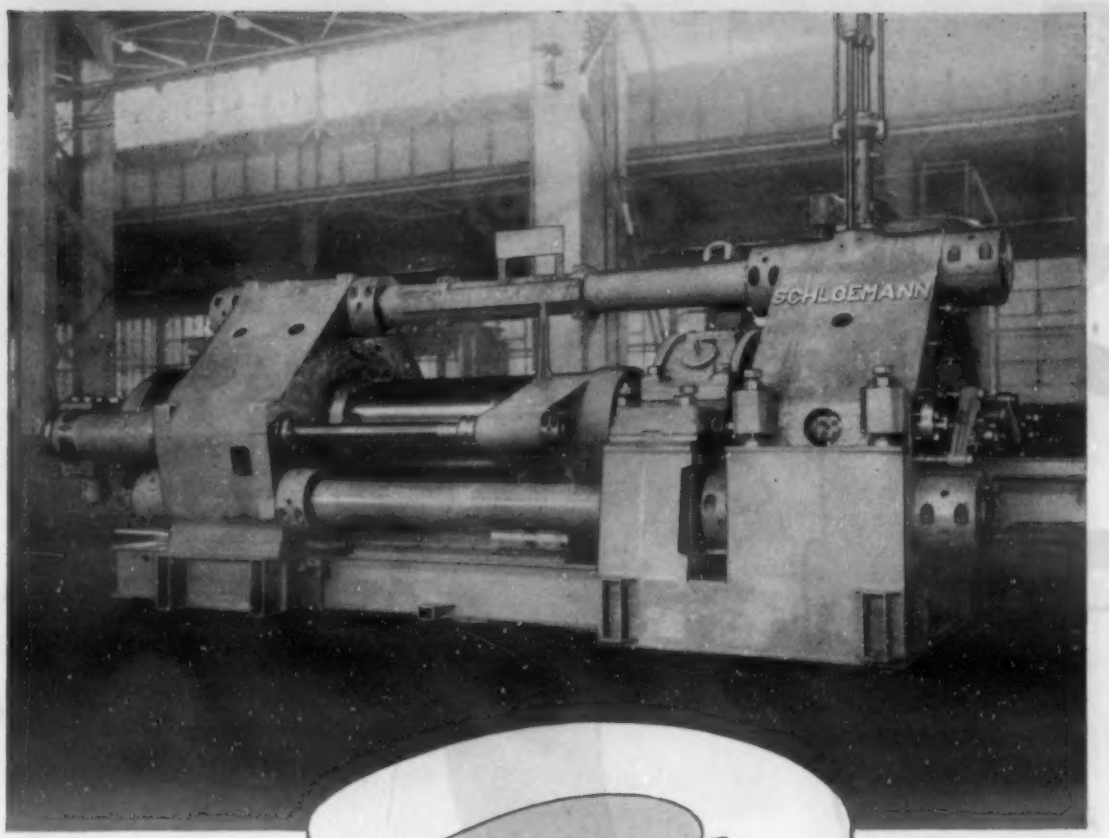

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temperature is equal to the ductility and toughness of open-hearth of the same tensile strength. (3) Ease of welding and metallurgical effects adjacent to welds of killed Bessemer are better than from open-hearth of same tensile strength. (4) Cleanliness and carburizing qualities of killed Bessemer are equal to those of corresponding open-hearth grades.

(5) Susceptibility to strain and the amount of blue-heat brittleness developed by killed Bessemer is similar and approximately equal to strain-aging of killed open-hearth of the same tensile strength, finished with the same deoxidation practice. (6) Creep strength of fine-grained killed Bessemer is higher than that of open-hearth steel finished with the same deoxidation practice.

—E. C. Wright. *Metals Tech.*, Vol. 11, June 1944, T.P. 1692. 17 pp.

Electrometallurgy of Ferro-Alloys and Iron

Condensed from
"Blast Furnace and Steel Plant"

Electric furnaces for production of ferro-alloys are generally of the low-shaft type. They may be considered as being immense crucibles, with or without a cover, using three-phase current. The single-phase open furnace with carbon bottom is also used for ferro-alloys not easily produced in the blast-furnace.

Where possible, their operation is continuous. Less fusible ferro-alloys are made by the "block" method in a furnace with a removable top. The furnaces are of the resistant arc reduction type and use a-c. of about 175 volts and a current density of 30 to 50 amp. per sq. in.

Standard ferromanganese and pig-iron may be produced either in the blast-furnace or electric smelter. Relative cost of electric current and fuel is usually the determining factor. Parity is when the cost of one kwh. equals that of two pounds of standard coke.

The Tysland-Hole or Spigerverk and the Siemens-Halske low-shaft furnaces produce most of the electric pig-iron in Europe. The first is so filled that the stock lies against the lining, protecting it and affording less strain on the electrodes.

At least one day's product remains in the furnace at all times, which produces the same effect as a mixer, and permits electrical control and prompt additions of stock to meet emergencies. Electric metal is far more regular than that obtainable from our most modern blast-furnaces.

It can be operated under varying electric loads without materially affecting output. It can readily handle high-sulphur materials and produce pig-iron with less than 0.03% sulphur. Any carbonaceous fuel will do. Calcite is preferred as flux, although dolomite will suffice. Precalcination is preferred in that useless carbon dioxide is eliminated.

The gases obtained are applicable to any use other than at the furnace itself. About 20,000 cu. ft. of 260-B.t.u.-per-cu.-ft.-gas are obtained per ton.

Electric Pig Iron

The Siemens-Halske furnace is similar to the Spigerverk type, except that it uses the

A FEW FACTS ABOUT CORHART PRODUCTS

Corhart Electrocast Refractories are high-duty products manufactured by melting selected and controlled refractory batches in electric furnaces, and casting the molten material into molds. After careful annealing, the finished shapes are ready for shipment. Dense, high-melting refractories, they are especially designed for resistance to corrosive action.

PRODUCTS

CORHART STANDARD ELECTROCAST is a high-aluminous refractory.

CORHART ZED ELECTROCAST is Zirconia-bearing.

CORHART ELECTROPLAST is a high-temperature plastic refractory made from Standard Electrocast which has been ground and crushed. Especially designed for ramming. Furnished dry.

CORHART MORTAR is a high-quality cement for laying up Electrocast, clay brick, or any aluminous refractory.

CHARACTERISTICS OF STANDARD ELECTROCAST

POROSITY: Less than 0.5%—therefore virtually no absorption.

FUSION POINT: Cone 38 without any appreciable softening below that point.

HARDNESS: 8, Mineralogist's scale.

SPECIFIC GRAVITY: Blocks weigh approximately 183 lbs. per cu. ft.

COEFFICIENT OF EXPANSION: 0.000006 between room temperature and 900° C.

SPECIFIC HEAT: 0.25 cal. per gm. per °C. at 980° C.

THERMAL CONDUCTIVITY: 25 BTU per sq. ft. per hour for gradient of 1°F. per inch.

COMPOSITION: Standard Electrocast is of an aluminous crystalline nature.

CORROSION: Because of low porosity and inherent chemical make-up, Corhart products are highly resistant to corrosive action.

APPLICATIONS

Most heat processes present spots where a better refractory material is needed in order to provide a balanced unit and reduce the expense of repeated repairs. It is for such places of severe service that we invite inquiries regarding Corhart Products as the fortifying agents to provide the refractory "balance" desired.

The following is a partial list of applications for which Corhart Products are suggested:

ELECTROLYTIC CELLS — for production of Magnesium and other light metals.

SILICATE OF SODA FURNACES — sidewalls, bottoms, and breastwalls.

HEARTHS AND SMELTERS — for non-ferrous metals.

ALKALI AND BORAX MELTING FURNACES — fast-eroding portions.

GLASS FURNACES — the entire installation of flux walls and bottoms, breastwalls, ports, tuckstones, forehearths, recuperators, etc.

RECUPERATORS—tile, headers, separators, etc.

ENAMEL FRIT FURNACES — flux walls and bottom.

BRASS FURNACES — metal contact lining.

ELECTRIC FURNACES — linings for rocking type, and rammed linings of Electroplast for this and other types.

BOILERS — clinker line.

STOCK SHAPES AND SPECIALS

Standard and Zed Electrocast are made in stock shapes and in many special shapes. The weight of individual pieces may run to 3500 pounds.

IF YOU NEED A BETTER REFRACTORY—

● Corhart Electrocast Refractories are high-duty products which have proved considerably more effective than conventional refractories in certain severe services. If your processes contain spots where a better refractory is needed to provide a balanced unit and to reduce frequent repairs, Corhart Electrocast Refractories may possibly be the answer. The brief outline at the left gives some of the basic facts about our products. Further information will be gladly sent you on request.

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FOR CLEAN STEEL

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LUNKE-RITE — an extremely effective exothermic, powdered compound for the control of piping in steel ingots poured *with* or *without*, hot tops; and in steel castings. It increases ingot yield considerably. The additional heat created has a beneficial effect on quality of steel by reducing rate of cooling in center section of ingot, which has been found to prevent internal cracks and laminations. This fact is especially important for large forging ingots.—Also used for fitting ladle stopper into nozzle;—as covering of nozzle and stopper head, which, as several plants claim, eliminate any dripping during the pouring;—as cover on steel in ladle where duplexing or reladling is practiced;—as cover on hot metal being transported a distance from blast furnaces.

A grade of LUNKE-RITE for every need.

RITE-MELT CLEANSER — a strongly effective powdered compound, containing no aluminum, placed on bottom of ladle just before tapping heat; or into stream as soon as it begins to flow into ladle; preferably on bottom of mold, thereby gaining greater advantage by preventing stool-stickers.

RITE-SULPHUR REDUCER — put on bottom of ladle just before tapping heat; or into stream as soon as it begins to flow into ladle. Reduction according to original content of Sulphur.

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Additional Products:

RITE-TONERDE — finest levigated alumina.

GREEN-ROUGE POLISH—levigated chromic oxide.

MILD POLISH—levigated tin oxide.

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P. O. BOX 448 NEWARK 1, N. J.

prefabricated type of electrode made continuous by the "nippling" method. This furnace is more centrally charged with greater load on the electrode and less cooling effect on the hearth. It is effective under conditions which the normal blast-furnace can not meet.

Normally it may be assumed these furnaces will produce pig-iron with a consumption of 700 lb. of inferior fuel, 2000 kwh., and 2 man-hr. of labor per ton. These conditions do not exist in the principal steel producing centers of North America, so that the electric smelter is non-competitive with our present-day blast-furnace.

In certain locations where cheap electric current is in contact with fuel and iron ore, it is possible to establish electric smelting unit on a competitive basis. Iron foundries of fairly large capacity can use the electric furnace.

The electric furnace should be particularly adaptable to the production of recarburizing metal. It should be a welcome addition when inserted in the circuit of any steel plant, for it is completely flexible, may be shut down over the week-end, and much of the current will come from excess available electricity.

—Charles Hart, *Blast Furnace & Steel Plant*, Vol. 32, June 1944, pp. 673-674, 691-694.

Detinning Metal Cans

Condensed from "Heating and Ventilating"

About 300,000,000 No. 2 cans will be handled by the new detinning plant of Southern Detinning Co. Besides interest in the process itself, there were problems of design brought about by the substitution of common material for critical items.

Of the 18,900 ft. of pipe installed, 13,000 ft. are welded pipe. The all-iron restriction on piping caused no difficulty because schedule 40 standard steel pipe is being used throughout.

Welded pipe is used for all lines 2 in. and larger; threaded pipe for lines 1½ in. diameter and smaller. Standard prefabricated welded fittings were used for elbows and flanges.

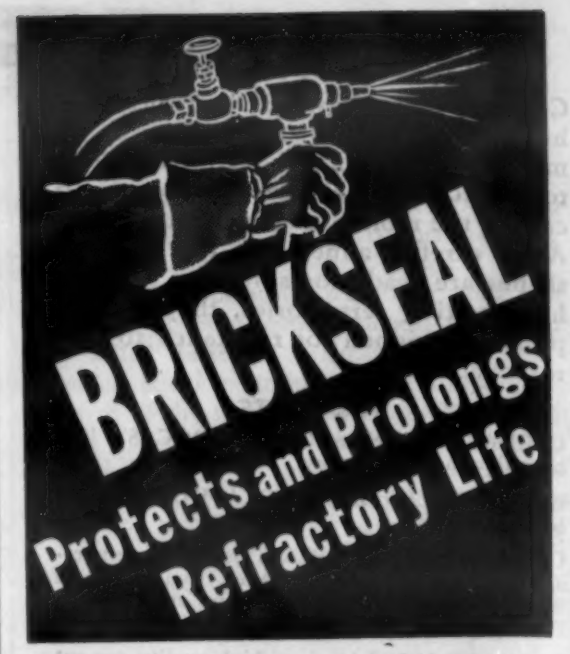
For heating detinning drum tanks and wash drum tanks 2-in. welded steel pipe coils were built on the job for use with steam. Where connections were needed, a ½-in. steel plate was welded to the metal lining.

Valves on the process lines are 175-lb. OWG all-iron lubricated plug valves while those 2 in. and larger are flanged. Plug valves were selected because of the solutions employed in the process. After construction pipes were painted with lead and oil paint.

Twenty-four pumps used have impellers to pass one-in. solids, and are of iron. All pumps are provided with water gland seals supplied from one pump handling clean water.

Steel pipe used for water was given a coat of asphalt, wrapped in burlap, and given a final coat of asphalt.

—C. P. Stolberg. *Heating & Ventilating*, Vol. 41, May 1944, pp. 41-48.

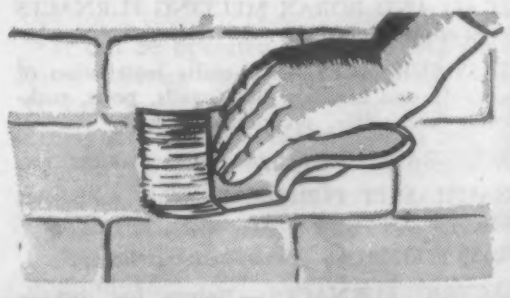


Applied like paint, prevents cracking and spalling

Now, more than ever, anything which prevents interruption of furnace production is of vital importance. Brickseal refractory coating prolongs the life of new or old brickwork by preventing disintegration due to cracking, spalling and slagging.

Brickseal consists of high-fusion clays and metals combined in oil. Furnace heat drives off the oils and vitrifies the clays and metals, permanently binding the bricks with a highly-glazed, vitreous, monolithic coating, impervious to gases, carbon and air infiltration. The highly reflective surface keeps heat inside the furnace and increases its efficiency.

At operating temperature Brickseal becomes semi-plastic so that it expands and contracts with the wall, and therefore cannot crack, peel or blister due to sudden temperature variations. This feature also enables Brickseal to bind loose brickwork and old cracks. Slag and clinkers can be removed without damage to lining. Brickseal is applied easily with brush or spray gun, and the furnace may be fired at once. At very little cost, Brickseal will assure longer, uninterrupted production. Write for sample.



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REFRACTORY CO.
1029 CLINTON ST., HOBOKEN, N. J.

Which ticket gets YOUR vote?

PRESENT OLD HEARTH

(worn-out, badly fouled, unreliable)

- ☐ Uneven bottom, weakened with accumulated lime, slag, steel
- ☐ Constant danger of boils
- ☐ More off-grade steel
- ☐ Increased delay time for hearth maintenance
- ☐ Lessening ingot output

NEW BASIFRIT SURFACE

(sound, clean, safe, dependable)

- ☐ Smooth working bottom of dense, monolithic refractory
- ☐ No interruption of heats
- ☐ Steel quality protected
- ☐ Minimum delay time between heats
- ☐ Increased production

VOTE to get rid of that old, uncertain open hearth bottom right away. Resurface with Basifrit, the quick-setting, high-magnesia refractory with a record for dependability.

Now, when you have to drive each furnace to produce every possible ingot, don't take a chance on tapping an off-grade heat that's been contaminated by a badly fouled bottom. Don't let production slow down due to more and more delay time, trying to patch an undependable old bottom.

Actually, it will save time to take time now to clean all lime, slag and steel out of an old hearth and resurface it with Basifrit. Then you can make steel faster—on a sound, clean bottom which protects quality—and delay time between heats will be reduced to a minimum, quickly making up the hours spent in installing the Basifrit.

BASIC REFRACTORIES, INCORPORATED *Cleveland 15, Ohio*

2 Foundry Practice

Melting and Pouring of Gray Iron, Malleable, Steel, Brass and Bronze, Aluminum and Magnesium Castings • Molding, Core-Making, Gating and Risering, etc. • Foundry Furnaces, Refractories, Ovens, Molds, Sands, Binders, Auxiliary Equipment and Materials

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Shrinkage in Iron Castings — 680

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Casting Heavy Metals — 682

Molding Sands and Casting Defects — 684

Shrinkage in Iron Castings

Condensed from "Foundry Trade Journal"

Shrinkage, the decrease in volume while cooling in the liquid state and undergoing solidification, and porosity, the occurrence of voids or discontinuities within the structure of the metal, have their origin in that time between the filling of the mold with molten metal and complete solidification.

As regards shrinkage and minimum segregation, the most suitable composition would be the eutectic. In practice it is an uncertain business to rely on the expansion due to graphite in compositions above the eutectic, for this graphite may commence to precipitate (as kish) while the iron is molten, and its effects on the actual solidification zone are thus considerably reduced.

In the main, the bulk of light iron castings range from 2.0 to 2.5% Si and 3.2 to 3.5% C, the stronger grades of iron being on the lower limits for both carbon and silicon. With irons in the lower effective carbon ranges, the increase in temperatures at which solidification commences is important.

The hotter the pouring temperature, the greater provision should be made for feeding. First, there is a decrease in volume in the liquid state, this being increasingly important with increasing size of casting. Then, due to increased temperature of the mold, solidification in the heavier sections tends to take place more slowly, giving time for segregation and for "self feeding" of the earlier freezing section.

With high-duty irons, the inoculated types particularly, higher pouring temperatures are used to get the best results in physical properties, as well as ensuring, in many cases, machinability and freedom from mis-running in the lighter sections.

With the higher silicon, higher carbon irons, there is less shrinkage to cope with. With such irons the principle of flash gates into thin sections with the heavier sections if possible in the drag, and generally little provision for feeding, is commonly employed.

In the case of normal flake graphite structures, it is highly probable that the formation of graphite is spread over a considerable portion of the solidification period, so that the expansion due to graphite may not be very effective in counterbalancing the shrinkage of the iron. This is particularly the case with variable section thicknesses, where solidification takes place at different times in different parts of the casting.

With the fine graphite structure, however, this separation occurs at a lower temperature than normal, solidification of the undercooled iron being extremely rapid and graphitization virtually instantaneous. As a result of this sudden graphitization, an intense pressure is set up in the interior of the metal due to the increasing volume required to accommodate the graphite.

—C. A. Payne. *Foundry Trade J.*, Vol. 73, May 11, 1944, pp. 23-29.

Centrifugal Casting of Steel

Condensed from a Paper of the American Foundrymen's Association

Compared to static steel casting, centrifugally cast steel may realize the following principal advantages: (1) Increased soundness and cleanliness, (2) higher yield, (3) simplified inspection, and (4) adaptability to mass production.

Compared with forging, centrifugal casting may show the following advantages: (1) Producing parts nearer to finished dimensions with consequent saving in machining, (2) lower equipment cost than for forging dies and presses, and (3) production of parts free from directional properties.

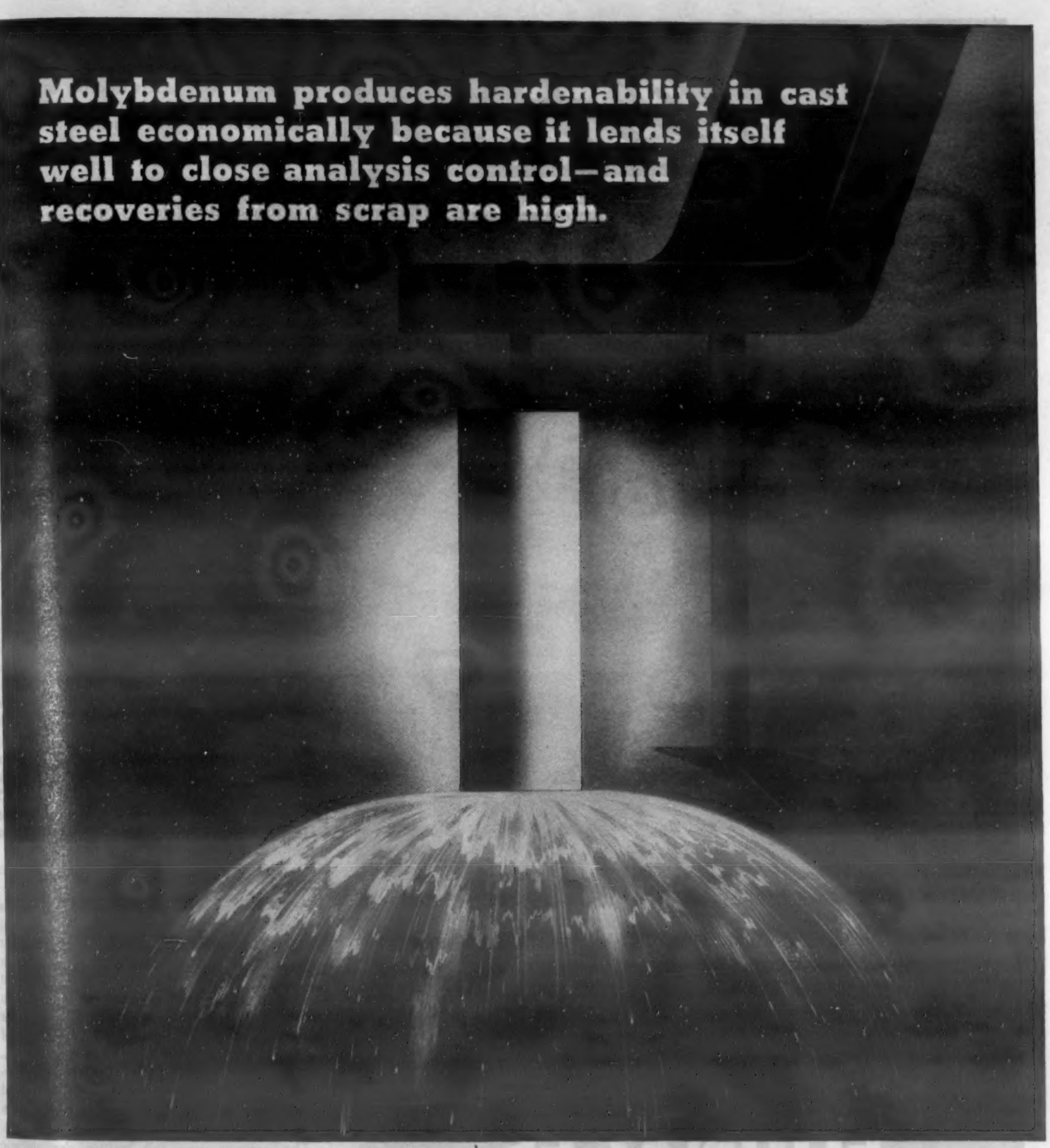
Centrifugal casting may be classified as: (1) centrifuging, in which molds are symmetrically placed around a central downgate and metal is fed through radial ingates by centrifugal force; (2) semi-centrifugal casting, in which a mold is spun about its own axis, but cores are used to form the internal diameter; and (3) true centrifugal casting, in which the mold is spun about its own axis, and some or all of its interior surface is formed by centrifugal force.

Mold material may be either sand or metal (soft gray iron or low carbon steel), depending upon the design and the number of castings required.

In spinning about a horizontal axis, the central cavity is cylindrical; when the axis is inclined or vertical, the cavity is parabolodial. For horizontal work, the spinning speed is critical. If it is too slow, a "raining" effect occurs that may cause laps and entrapped oxides, whereas, if it is too fast, the casting may shrink from the mold sufficiently to develop high circumferential tension and produce longitudinal hot tears.

The r.p.m. should be such for sand molds that a centrifugal force of approximately 75 times gravity is produced at the inside diameter.

Molybdenum produces hardenability in cast steel economically because it lends itself well to close analysis control—and recoveries from scrap are high.



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Climax Molybdenum Company

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MOLY

Microstructure and physical properties are very nearly the same in centrifugally cast steel as in the same steel statically cast. However, there is less tendency toward the formation of pinhole porosity in true centrifugal castings than in static castings made in green sand molds.

Therefore, powerful final deoxidizers such as aluminum can be avoided and increased ductility at any given strength, particularly at high strengths, results. Moreover, in true centrifugal casting, solidification takes place progressively from the outside surface to the internal wall and internal shrinkage cavities do not normally occur.

—C. K. Donoho. *Am. Foundrymen's Assn.*, Apr. 1944 meeting, Preprint No. 44-32, 17 pp.

Casting Heavy Metals

Condensed from "Giesserei"

Gases and metal oxides in the casting and melting of heavy metal alloys give unfavorable effects. Oxygen is not to be considered a gas in this connection, as it is insoluble in the metal and is present as a metal oxide, behaving differently from other gases.

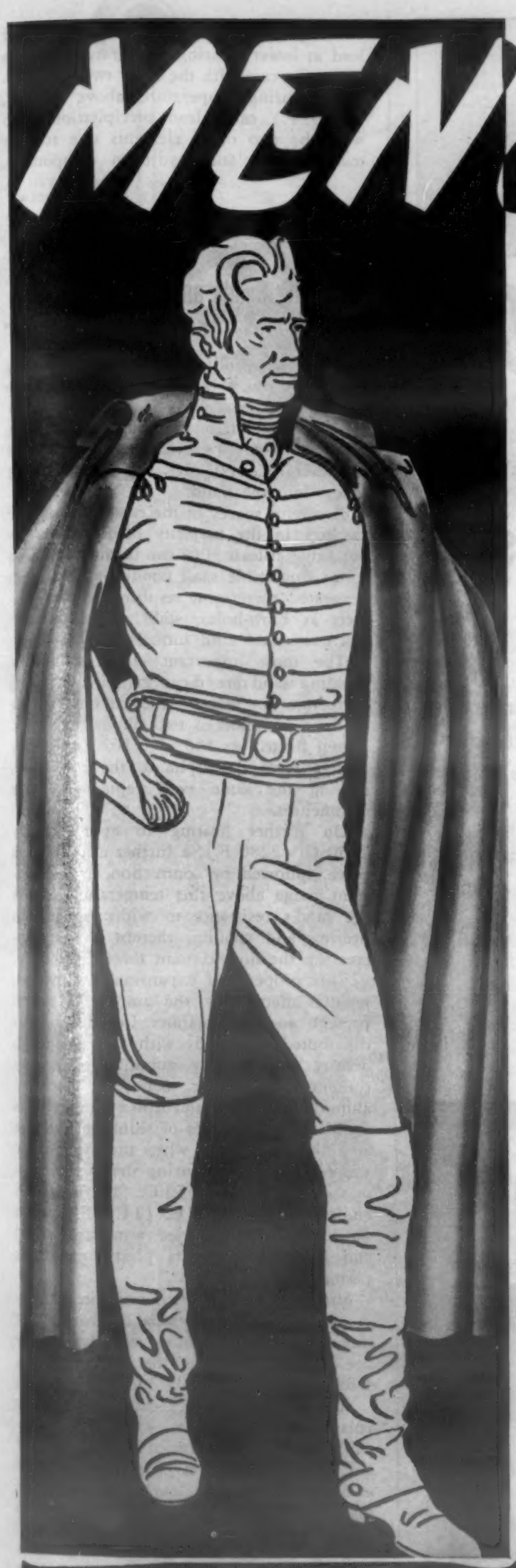
Normal copper contains 0.025 to 0.050% O_2 in the form of cuprous oxide; 0.05% O_2 corresponds to 0.45% Cu_2O. The presence of oxygen is necessary, as copper with less than 0.015% rises after pouring in the form because the gases in the copper react with the oxygen of the air to form water vapor. This escapes quickly in the transition of the copper from the liquid to the solid state and leaves pores. Furthermore, an oxygen content of 0.025 to 0.05% is desirable in order to bind the lead usually contained in the copper in amounts of from 0.01 to 0.03%.

Lead-bearing copper with less than 0.02% O would be useless not only because of gas content connected with this percentage, but because the lead not bound by oxygen as lead oxide is precipitated at the grain boundaries and causes grain boundary cracks in hot-working. It is not advisable to pour copper with more than 0.02% Pb, although it is quite possible to work copper with a lead content of 0.15% in presence of 0.04 to 0.05% O_2.

In order to counterbalance the unfavorable effect of bismuth on the mechanical properties of copper, five parts of oxygen must be present for each part of bismuth. The oxygen does not reduce the electric conductivity, and the specific mechanical properties of the copper are not at all impaired by the cuprous oxide.

Oxygen and also hydrogen can be completely eliminated by addition of lithium. Completely oxygen-free copper is superior to copper with normal oxygen content in elongation, contraction, impact strength and toughness.

To produce good lead bronzes, the melt must be free of gases and metal oxides, eventually with a slight excess of deoxidizer, *e.g.*, phosphorus or lithium. Gas-containing lead bronzes should be poured at 1050 to 1110 C. (1920 to 2030 F.), and can be made to solidify very densely by addition of phosphorous, magnesium, calcium, etc.



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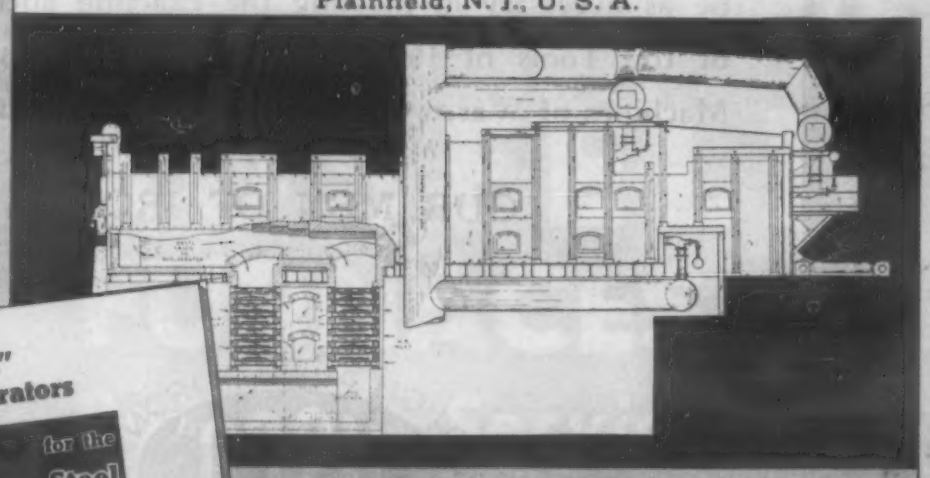

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Phosphorus causes strong segregation of lead at lower pouring temperatures, which is not the case with the latter two elements. High pouring temperatures above 1120 C. (2050 F.) cause lead precipitations also with the two other elements due to formation of volatile hydrogen compounds.

—P. Klare. *Giesserei*, Vol. 29, Nov. 27, 1942, pp. 404-407.

Molding Sands and Casting Defects

Condensed from "Foundry Trade Journal"

Of the controlling factors in producing sound castings with good skin finish, those that predominate above all others are (a) the condition of the molding sand and the reaction of the finished mold at elevated temperatures, and (b) the generation of gases from the mold.

A careful survey of the cause of defective castings in the majority of foundries reveals that at least 50% can be directly traced to an unsuitable sand condition and gases generated therefrom, resulting in such defects as blow-holes, scabs, burnt-in sand, gas seams and sand intrusions.

The most important characteristics of molding sand are those exhibited at high temperatures. When subjected to heat, the sand grains undergo two physical changes. When heated to 550 C. (1020 F.), they change from the alpha to the beta state, and at the same time rapid expansion commences.

On further heating to approximately 1250 C. (2280 F.), a further change takes place, followed by contraction, and a constant usage above this temperature lowers the sand's resistance to withstand sudden heating and cooling, thereby slightly increasing the fines content through fracture.

This property of expansion is, however, greatly affected by the amount of bond present and the manner in which it is distributed, coupled with the resulting density produced by ramming. The clay content, comprising collodial, hydrated aluminum, silicates and iron oxide, exhibits on heating two stages of shinkage, the first at 100 C. (212 F.) when the hydroscopic water is driven off during drying; the second commencing at 550 C. (1020 F.) and ending at about 800 C. (1470 F.), when the chemically combined water is evolved and the clay loses its plastic properties permanently.

Shrinkage and dehydration are largely controlled by the alumina content of the clay which, if high, causes excessive shrinkage. Coal dust, under the action of heat, softens at approximately 350 C. (660 F.).

At 450 C. (840 F.) distillation of the volatile matter occurs, which is accompanied by the evolution of large volume of gas. This evolution is generally completed at 800 C. (1470 F.), leaving coke particles that fill up the voids between the sand grains.

It is generally agreed that all sands require a definite moisture content ranging from 5 to 6% for green sand work, and from 8 to 10% for dry sand work, to give the required strongest condition of the finished mold.

—G. W. Nicholls. *Foundry Trade J.*, Vol. 73, June 1, 1944, pp. 85-91; June 8, pp. 111-114, 116

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purchases MONARCH of Baltimore, Maryland

FISHER FURNACE CO. BUYS ALL RIGHTS OF MONARCH ENG. & MFG. CO.

The industrial furnace business of the Monarch Engineering and Manufacturing Company of Baltimore, Maryland, has been purchased by the Fisher Furnace Company of Chicago. The transaction gives the Fisher Furnace Co. all rights to manufacture Monarch Equipment and includes all patterns, drawings and parts inventories.

Future plans provide for the continued manufacture of certain specialized Monarch Furnaces with improved design features, and the continuation of a complete parts service for Monarch Furnaces now in operation. All Monarch Furnaces to be carried over into the Fisher Line will be subjected to a thorough revamp and modernization program by the Fisher Engineering Department at Chicago. Combined headquarters and manufacturing facilities will be located in the two existing Fisher plants in Chicago for the present.

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9 Metal-Working and Treating

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Atmospheres for Heat Treatment

Condensed from "Industrial Gas"

The development of gaseous atmospheres has been rapid and very interesting. The first atmosphere used was dead air, used either in an electrically-heated furnace or in a gas-fired muffle-type furnace. The oxygen in the dead air inside the muffle soon combined with the metal being heated, but from then on practically no scale was formed. However, dead air did form some scale, and fresh air always leaked in.

Another early gas was straight raw gas, or gas and air, used particularly for carburizing low carbon steel. However, the gas cracks when heated to a high temperature, depositing carbon as soot and being difficult to control.

Pure hydrogen is satisfactory as to protection, but it embrittles some metals, is highly explosive and expensive. Inert nitrogen was found ideal, except that it is expensive and troublesome to handle.

Dissociated ammonia was tried as a protective atmosphere and, though protective enough, is costly except for certain special applications. Another plan was burning a mixture of gas and air in an extraneous combustion chamber, it being necessary to burn only a small quantity to get a rich atmosphere. However, the water vapor is very high, causing rapid scaling and decarburizing of steel.

Coolers were introduced to lower the dew point of the gas generated to about 80 F. This atmosphere had too much water vapor for bright annealing and clean hardening of steel. So a refrigerating unit that cooled the gas to 40 F. was introduced. It is ideal for bright annealing of copper.

For another atmosphere, gas is cracked in a generator at about 1800 F. in an externally-heated retort, and is water-cooled in an indirect cooler. It will also carburize low carbon and medium carbon steels. Disadvantages are that it deposits soot on the charge and alloy steel parts of the furnace, shortening the life of the latter considerably. It will bright anneal and clean harden higher-carbon steels.

Gradually the rules of "carbon balance" were learned in manufacturing atmosphere gases. If the carbon balance of the atmosphere is higher than the carbon content of the steel being heated, carburizing will result. If the reverse, decarburization takes place.

When molybdenum high-speed steels came along, there was needed an atmosphere of a far higher carbon balance than any available. There developed an atmosphere generated by passing air through a heated bed of charcoal in a vertical tube.

Water vapor difficulties are eliminated, there being no hydrogen involved. This atmosphere, when enriched with natural or propane gas, can carburize steels and will prevent scaling or decarburization of high carbon and high-speed tool steels.

By placing a catalyst inside the retort of a cracked gas unit, the oxygen will combine with the carbon and not with the hydrogen of the gas. It is quickly chilled after the cracking to stabilize it. It is ideal for carburizing, bright annealing and clean hardening of all types of steel, and has a high carbon balance.

The nitrogen atmosphere is a modification of the first type. The air-gas is burned with a deficiency of air to eliminate oxygen. It is passed through an absorber that removes the carbon dioxide and refrigerated.

—A. H. Koch. *Industrial Gas*, Vol. 23, July 1944, pp. 13-17, 30-38.

Carbide Milling of Steel

Condensed from "The Iron Age"

Carbide milling of steel with tungsten-titanium tips has been limited for such milling cutters as face, half-side, shell-end mills and slotting and slitting cutters. Inherent difficulties in the application and grinding of tips have thus far prevented its use in form cutters.

The technique of milling with carbide is limited to the use of negative angles both in the rake and helix. Cutting pressures with negative angle are applied to the tip away from the cutting edge an amount equal to the chip thickness, whereas in using positive angles cutting edge is directly stressed by the cutting forces.

High surface speeds are characteristic. There are indications that the lower surface rates (400 to 500 ft.) are advisable

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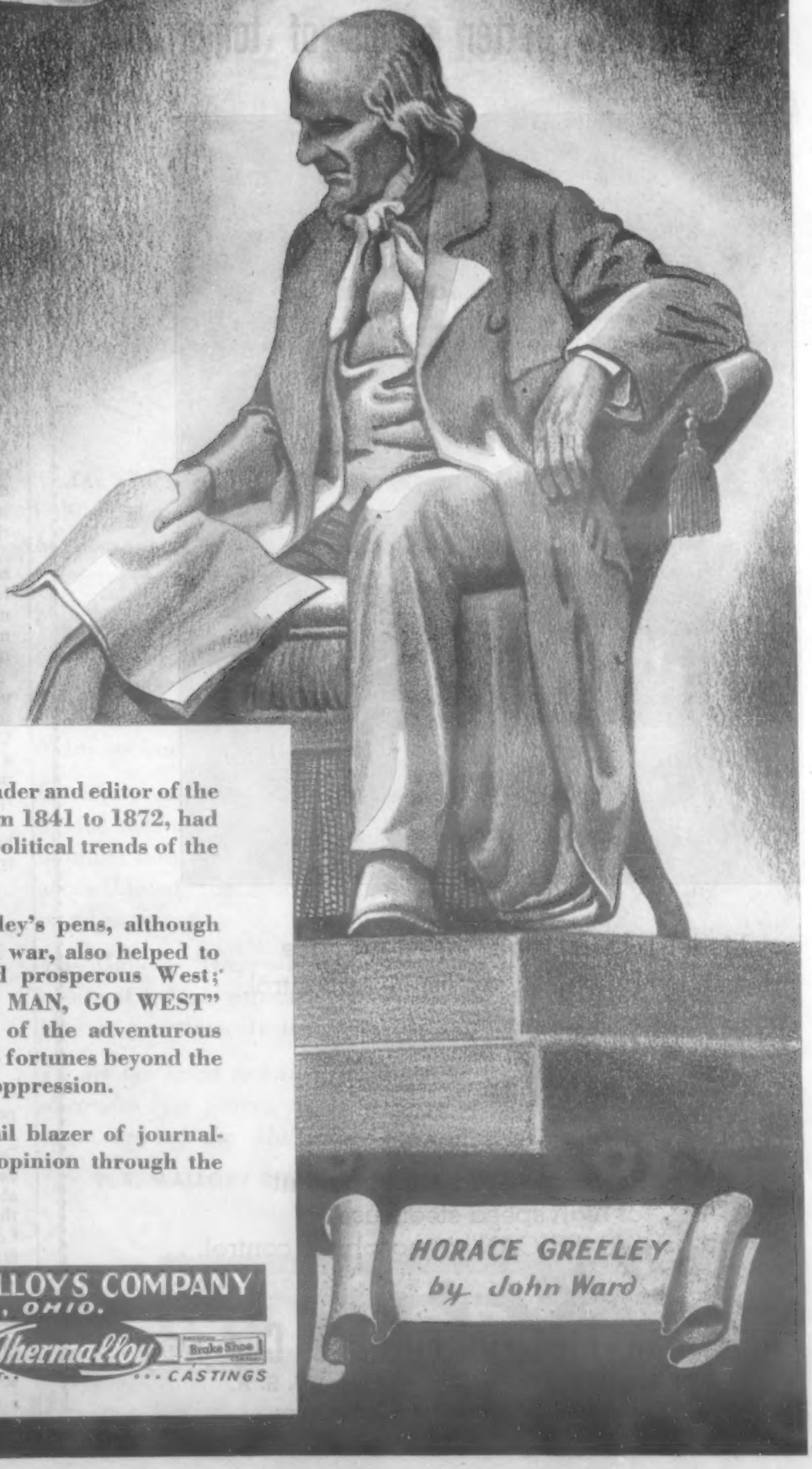

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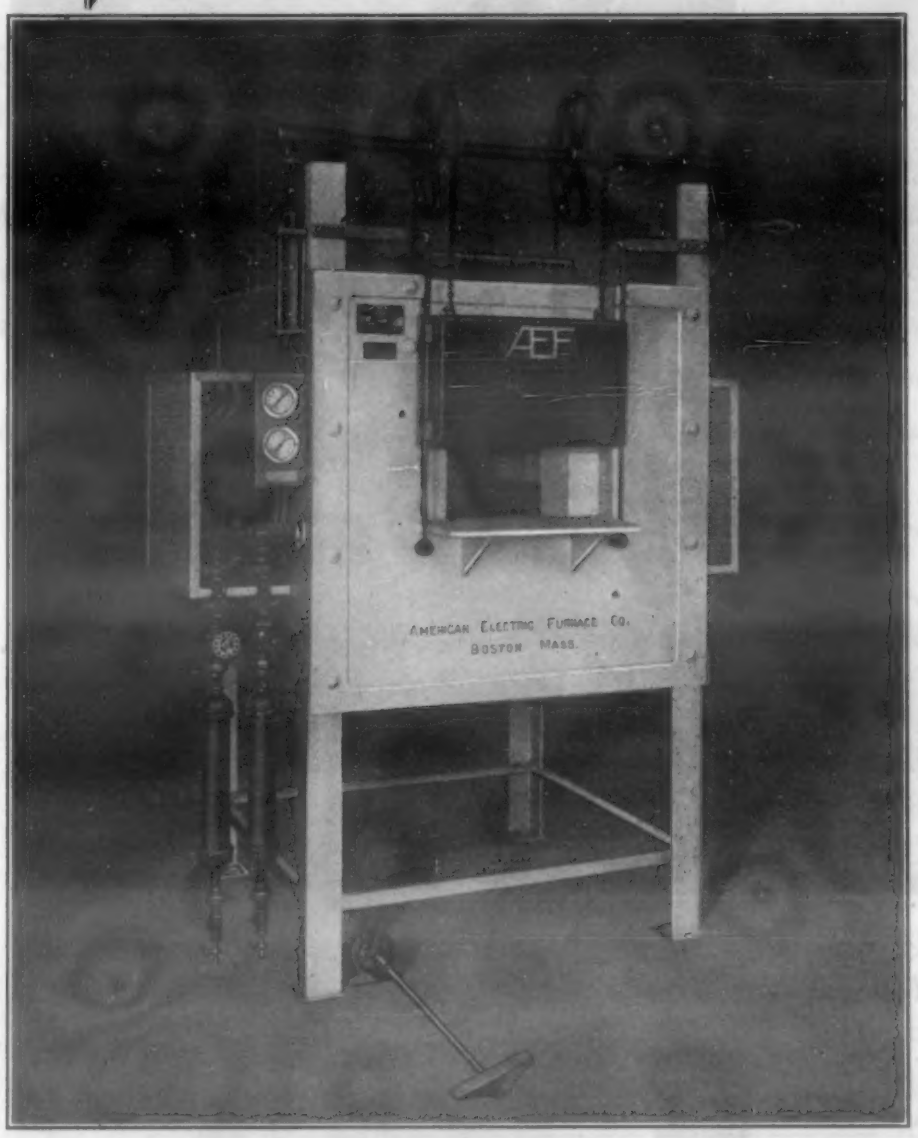

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for heat treated steels that are in the neighborhood of 375 to 425 Brinell. Untreated steels are being milled successfully at peripheral speeds as high as 800 to 1000 ft. per min. Where high finish is required (15 to 20 micro-in.) a high surface rate and low chip loads are necessary.

High chip load and good cutter life are related as cause and effect. The thicker the chip the farther from the cutting edge will the cutting forces be applied.

Horsepower consumed in carbide milling of steel is relatively high. Increase in cutting forces necessary to remove metal with negative angles amount to 15 to 20%.

Feed rate depends upon chip load, number of teeth and surface ft./min., current practice limits number of teeth employed in milling cutters. Pitch varies in different localities, but a rule-of-thumb that seems to strike an average can be expressed by the diam. in in. plus two.

Because of the coarse pitch cutters used in carbide steel milling, flywheel effect is essential. To eliminate undesirable effects resulting from large cutting forces and coarse pitch cutters, the flywheel should be installed on the arbor, or built into the machine spindle.

Results of tests showing relationship between depth of cut and horsepower indicate a straight line relationship. Since the ratio is greater than one, the increase in horsepower is proportionately less than the increase in depth of cut.

Present indications point to the advantageous use of combination of 7° negative rake and 7° negative helix for general milling purposes in face and half-side milling. In slotting a 0° helix and 15° negative rake is effective.

A carbide-tipped face mill cannot be used in a confined cut where the arc of contact between tip and work is 180°. Chip clearance can be provided by using a flycutter, coarse pitch cutter or reducing the chip load by increasing peripheral speed.

Results obtained with solid wedged carbide blanks point to the advantages of this type of construction.

—H. A. Frommelt. *Iron Age*, Vol. 153, June 22, 1944, pp. 52-57.

Buffing and Polishing

Condensed from "Metal Finishing"

Polishing is defined as "the smoothing of a metal surface by means of abrasive particles attached by adhesive to the surface of wheels or belts." Buffing is the "smoothing of a surface by means of flexible wheels, to the surface of which fine abrasive particles are applied, usually in the form of a plastic composition, or paste." Coloring is a "light buffing of metal surfaces, for the purpose of producing a high luster."

Usually about 0.0002 in. of metal is removed in polishing. However, with grease polishing with a fine abrasive no more metal may be removed than with buffing, while coarse polishing may compare with a solid grinding wheel in amount of metal removed. Most buffing operations remove about 0.0001 in. of metal.

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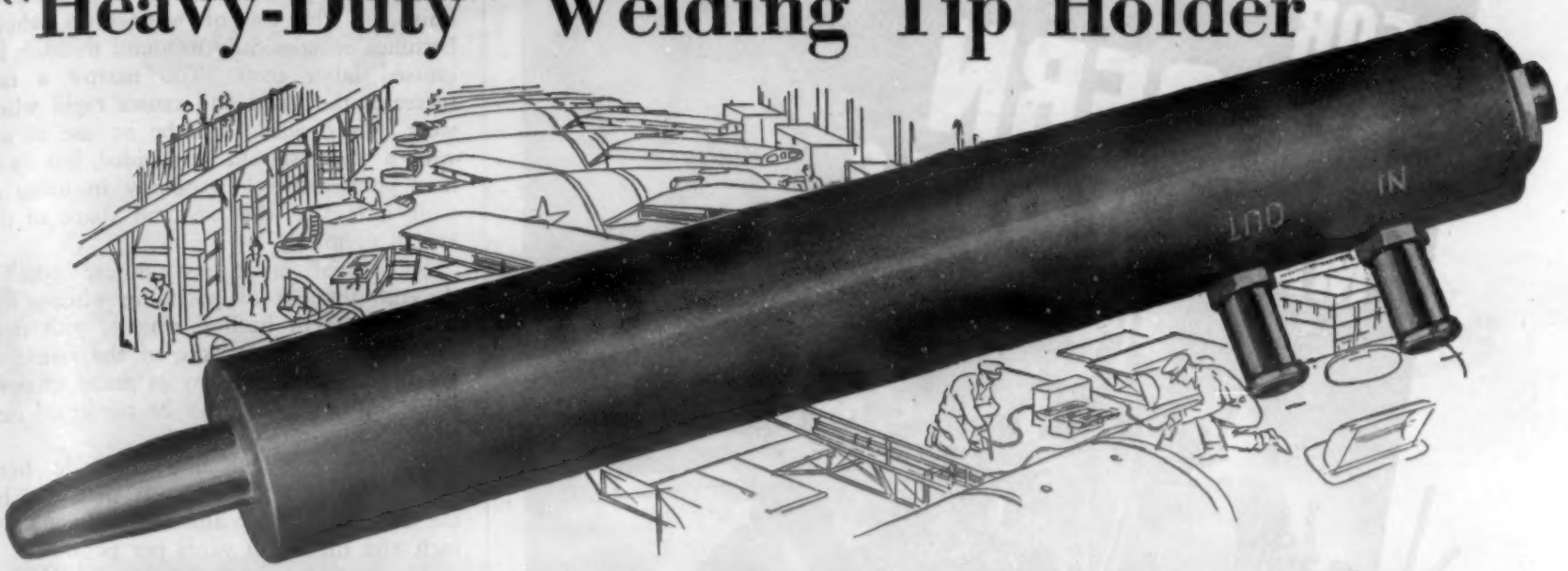

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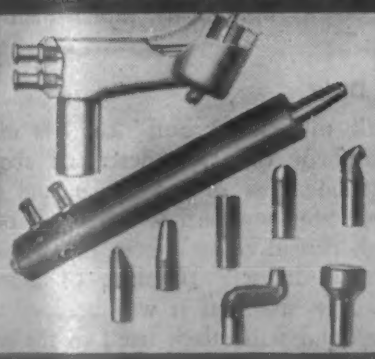

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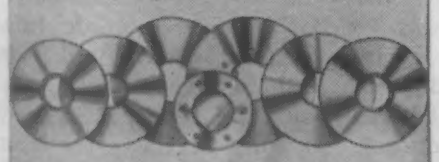

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A buffing or polishing wheel has three important dimensions which must be specified; the arbor hole diameter, the outside wheel diameter, and the face width. As a general rule, 7,500 surface ft. per min. is used in polishing, and 9,700 ft. per min. in buffing.

Wheel Size

Too small a wheel can materially increase the time required to produce a specified finish, so the use of worn-down wheels becomes economically unsound through increased labor costs. Too narrow a face increases the labor and causes rapid wheel wear. Overloading a lathe by use of too wide a wheel should be avoided, but up to that point there is economy in using as wide a face as the size and shape of the article permits.

Substantial labor savings are possible through the use of polishing wheels, and to some extent buffing wheels, with faces formed to fit the profile of the article to be finished. In this way as many as three polishing operations can be combined into one.

Most buffing wheels are made from cotton sheeting. Sheeting is described by the number of warp and filling threads per inch and the lineal yards per pound.

The best material for a given application can be determined by a few trials of buffs made of grades of sheeting between 48/48 and 84/92. A bleached material is usually harder and stiffer than an unbleached material, and is therefore more suitable for "cutting down" operations, rather than for "coloring."

Types of Disks

A "full disk loose buff" consists of a simple buff of the type described above, with just one row of sewing around the arbor hole. Such a buff, when made of a hard, high thread count fabric, can be used for "cutting down." If made of a soft, loosely woven material it will be ideal for "coloring" and will adapt itself to the contours of an irregular article.

Spiral sewed buffs are least expensive, because the sewing can be done on semi-automatic sewing machines. Concentric sewing is more expensive, but has the advantage that the face of the wheel does not tend to get wavy. With both of these types of sewing the hardness of the wheel is varied by varying either the distance between rows of stitches or the length of stitch.

Square sewing gives a stiffer buff than any other sewing, and yet the buff retains resilience. Square sewed buffs are recommended for heavy "cutting down" operations.

Sewed "pieced" buffs are made from waste pieces of fabric sewed together in jig-saw-puzzle fashion. These buffs compare favorably with full disk buffs in many applications. In spite of the extra labor costs involved in "laying-up" the small pieces, pieced buffs are substantially lower in price than full disk buffs.

Other special construction buffs, such as folded ply buffs and "puckered" buffs, were developed for high speed production with automatic buffing machines. These buffs have appreciable stiffness, and yet are flexible. Their construction facilitates adhesion of the buffing compound, allows better

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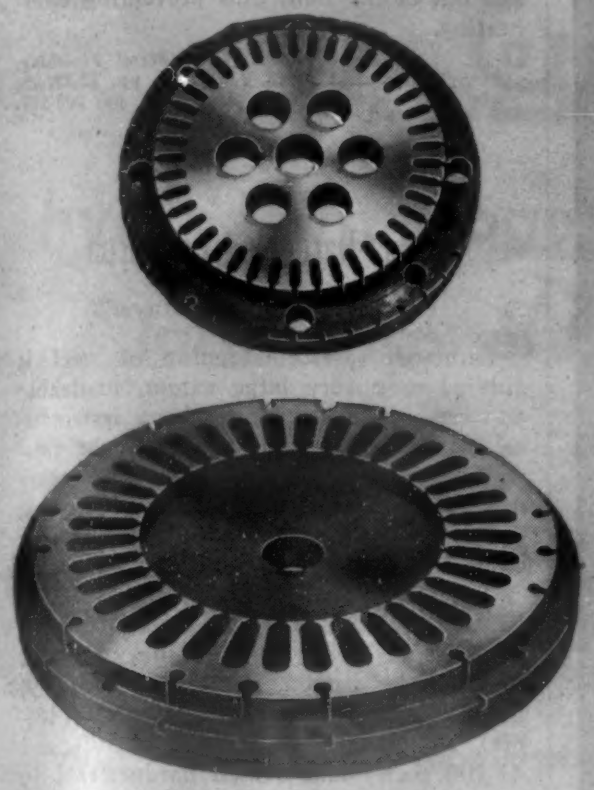

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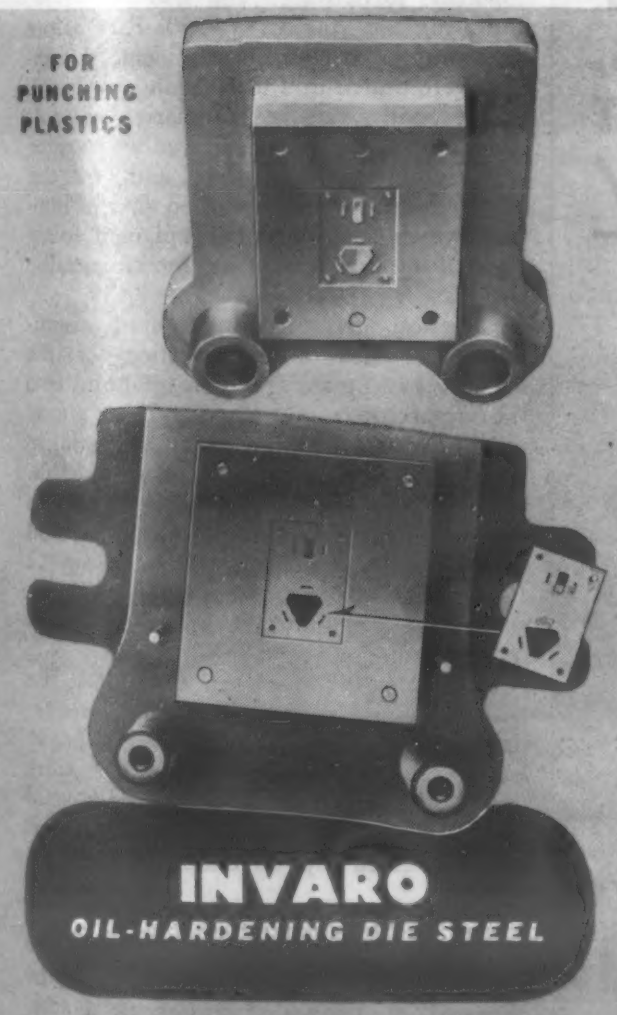

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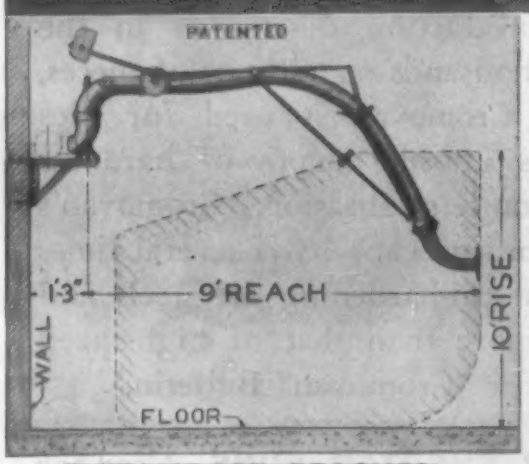

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penetration of the compound into the face of the buff, and allows exchange of air in and out of the buff, thus preventing overheating.

—Gerald A. Lux. *Metal Finishing*, Vol. 42, Jan. 1944, pp. 12-18, 41; Apr. 1944, pp. 203-207.

Flame-Hardening Cast Iron

Condensed from "Giesserei"

Although surface-hardening of steel is applied to a very large extent, malleable and cast iron have not yet been systematically investigated with regard to the possibilities and obtainable results. Tests were made with six different cast iron types, one of which contained 0.56% Mo, another 0.06% Mo.

Types used are Ge 12.91, 14.91, 18.91, 22.91, 26.91 and 32, with carbon contents of 3.09 to 3.58%; the tensile strengths, in the order named, are 13.1, 14.3, 16.9, 22.0, 25.7 and 33.1 kg. per sq. mm. (18,600, 19,300, 24,000, 31,300, 36,500, and 47,100 p.s.i.) and Brinell hardnesses 140, 170, 190, 210, 230 and 255.

The specimens were cylinders of 28-mm. diam. (1⅛ in.); tests were made for applicability of surface hardening for round bodies of such small diameter, determination of quenching temperature, surface hardness and hardness over the section, permanency under annealing, chemical examination and examination of the structure.

The specimens were hardened in the condition as delivered and also after 3-hr. annealing at 900 C. (1650 F.) before hardening. For comparison, identical samples were heated in a furnace and hardened.

The results can be summarized as follows: Ferritic cast iron showed an increase of hardness at the surface and, for the oven-hardened specimens, also in the interior, which could not be explained solely by the heat treatment of the ferritic metallic basic mass.

Chemical and metallographical examination revealed a carburization of the metallic basic mass from the graphite into the hypereutectoid range. The purely pearlitic cast iron showed an increase in hardness up to 550 Brinell at the surface. All hardened cast iron types possessed a good resistance against annealing, so that at annealing temperatures of 250 to 300 C. (480 to 570 F.) no reduction in hardness, even after 200 hours of annealing, could be detected.

In the ferritic cast iron Ge 12.91, the part of bound carbon increased in oven-hardening from 0.09 to 1.03%, in flame-hardening to 0.7% after 25 sec. heating time. No increase of bound carbon could be found in Ge 26.91 and Ge 32; this was confirmed by metallographic examination.

Soft-annealed specimens of the types of higher strength give in no case the same increase in hardness that could be obtained in unannealed specimens. Flame-hardening produced up to 150 Brinell units higher hardness values than hardening after heating in the furnace.

—G. Kritzler & H. Killing. *Giesserei*, Vol. 29, Dec. 25, 1942, pp. 429-437.

After more than 9,000 hours exposure to hydrogen-nitrogen atmospheres at 1450°-2000° F., large Inconel furnace tubes are still in service

At the Metal Forming Corp., Elkhart, Ind., welded tubing of various alloys is bright annealed at 1450° to 2000° F.

The furnace tubes, which carry the welded alloy tubing being annealed, must face hydrogen-nitrogen atmospheres, in addition to the destructive effects of the heat itself.

Early in 1943, large-size Inconel tubes were adopted for this severe service.

After more than 14 months of 24 hours a day, 7 days a week service, this photograph was made. The Inconel tubes, as can be seen, are still at work and still in good condition . . . after more than 9,000 hours of continuous operation.

* * *

High strength, ductility and excellent resistance to oxidation...these are the *combined* properties that uniquely fit Inconel for use in many high temperature applications.

INCO Technical Service is at your call to discuss individual metal problems. For information, address: The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

14 MONTHS CONTINUOUS SERVICE, *and still going strong. Large Inconel tubes, 5 9/16" x .250 wall, resist hydrogen-nitrogen atmospheres at bright annealing temperatures of 1450° to 2000° F. Used at Metal Forming Corp., Elkhart, Indiana.*

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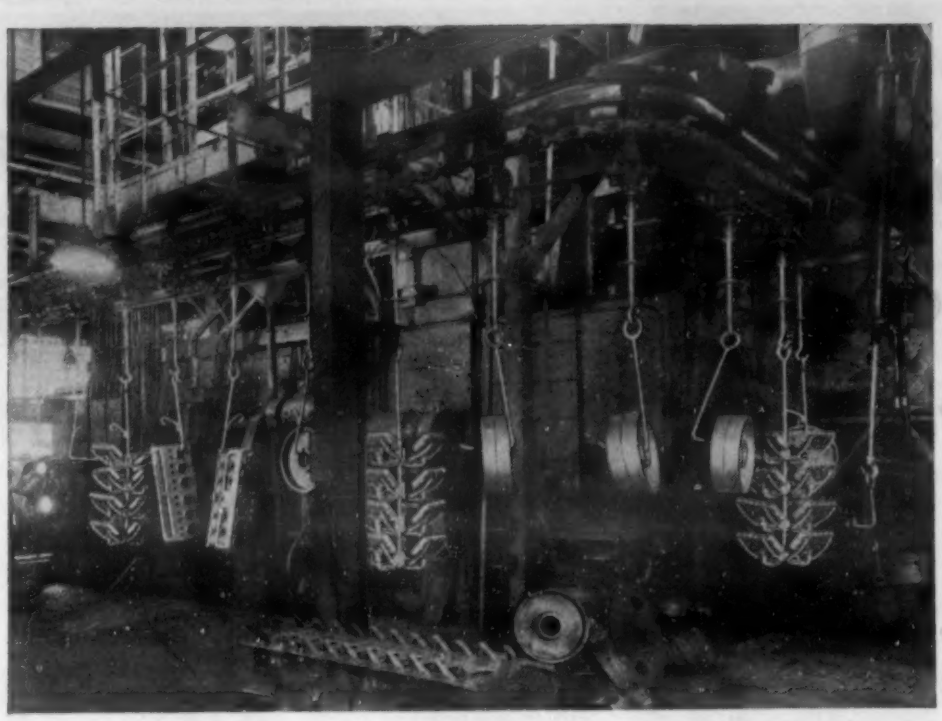

SOME ONE MUST PLAN AHEAD . . . WHY NOT YOU?

70.3% of all metal working plants in the U. S. expect to reconvert to peacetime production immediately after the war's end. Another 16.6% expect to be reconverted to civilian requirements one month later.*

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This is good manufacturing strategy. New parts, new Pangborn equipment may be the way to put your foundry in front in post war competition. You should KNOW THE FACTS—to GUESS is to ERR. Some one must plan ahead, why not YOU? Our Engineers will be glad to come out to see you NOW and discuss your plans for the future. No obligation, of course. For post-war preparedness "COME TO PANGBORN."

*Data compiled by Steel Magazine

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Improving Chromate Primer Adhesion

Condensed from "Products Finishing"

Zinc chromate primer is required by Army and Navy specifications for the corrosion protection of all metals and alloys used in aircraft manufacture. Before applying primer, steel and copper alloys are anodized, and magnesium parts are treated by the dichromate process or some other approved process. These processes offer additional corrosion protection and promote primer adhesion.

The most common reason for lack of primer adhesion to surfaces finished as above is improper cleaning prior to application of the zinc chromate.

The author believes that the most effective cleaner is a mixture of two parts of toluol or xylol and one part alcohol. This mixture dries quickly, leaves no residue, and the alcohol content is sufficient to remove any moisture that may be present.

When zinc chromate primer is applied to 24ST alclad to prevent abrasion of the soft 2S aluminum coating during storage and fabrication, the primer may dry with a very hard glazed surface before subsequent finish coats are applied. It is difficult to get good adhesion of the subsequent coats to such a surface.

When the coating has dried to this extent, it remains practically unaffected by hydrocarbon cleaners, or by the zinc chromate thinners. Unless the surface is slightly abraided or roughened, there is no "tooth" for the second coat, and adhesion will be poor.

The tedious cleaning and scuffing operation required to break down the primer glaze is made much easier by the use of aluminum wool. When used with the hydrocarbon cleaner, it penetrates the hard primer surface readily, yet it is soft enough so that it will not injure the anodized finish if it should cut through the primer.

The cost of the aluminum wool is offset by a saving of time and cleaning efficiency over the use of cloths and fiber brushes.

Two other methods for getting adhesion of zinc chromate primer to an aged coat have given good results experimentally, but no test is available on the quality of the adhesion after a 6-months aging period. The two methods are: (1) To apply a very thin intermediate coat (90% thinner, 10% primer); and (2) to apply a sizing coat of hydrocarbon solvent plus 2% phenolic varnish.

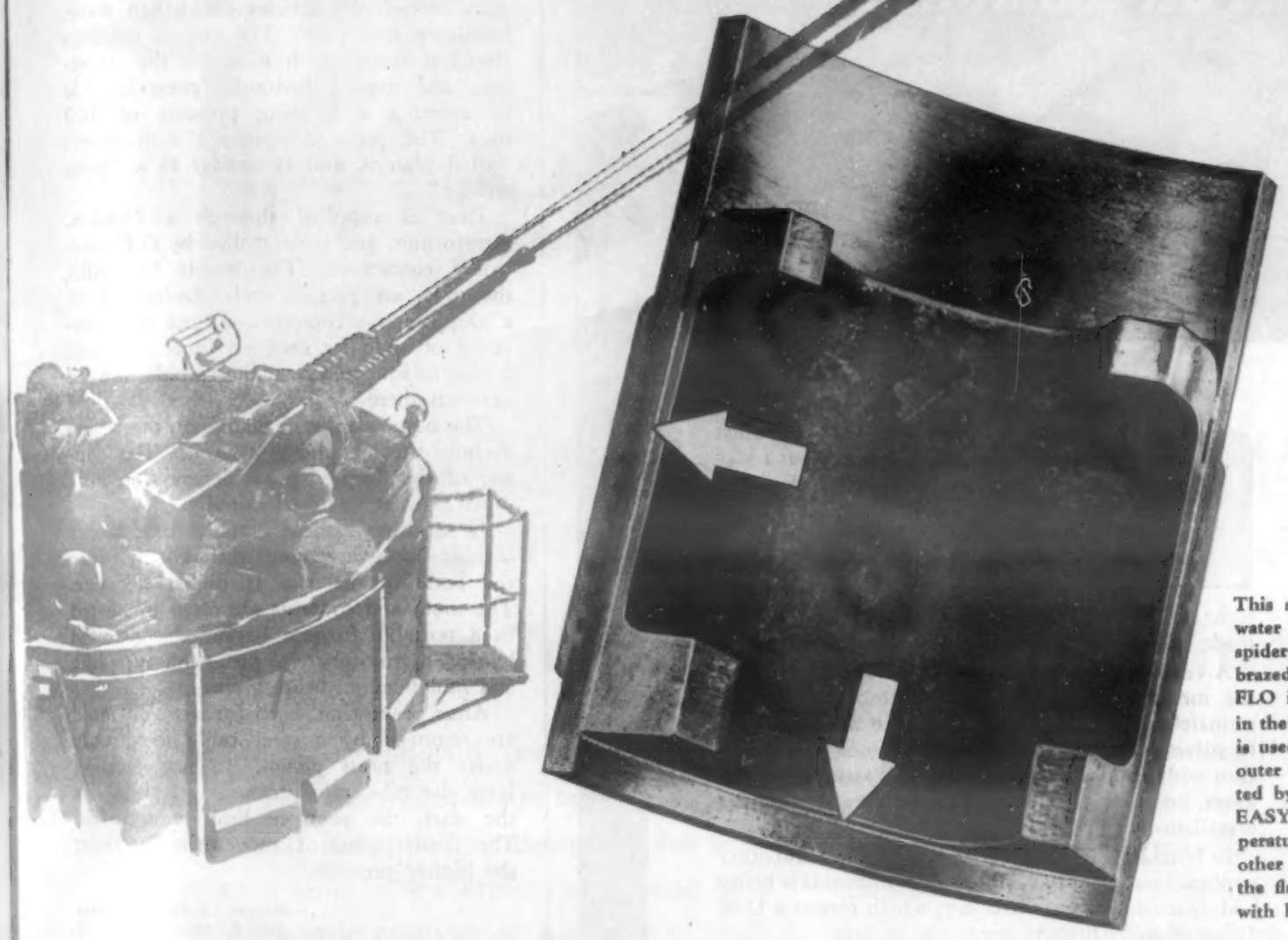
—J. F. Mason. *Products Finishing*, Vol. 8, June 1944, pp. 60-66.

Hot Pressing Carbide Parts

Condensed from "Modern Industrial Press"

A "hot press" method, which incorporates in a single operation pressing, semi-sintering and sintering, has been developed at Carboloy Co., Inc., Detroit. Cemented carbide parts, too large to be sintered in available furnaces, are thus produced. Some of the parts weigh up to 100 lb. for the carbide alone, handling jobs up to 100

EASY-FLO plays a part in keeping the Navy's BOFORS guns firing



This section of a Bofors gun water jacket shows how the spider plate is EASY-FLO brazed to the jacket. EASY-FLO is *preplaced* in a groove in the plate. Induction heating is used. Brass bearing ring on outer side of jacket is unaffected by the brazing because of EASY-FLO's low working temperature of 1175°F. Four other jacket joints and one on the flash hider are also brazed with EASY-FLO.

THIS is typical of hundreds of metal joining jobs now being done with EASY-FLO in the production of planes . . . tanks . . . ships . . . shells . . . guns and a wide variety of other war products.

It's the ability of this low-temperature, free-flowing silver brazing alloy to make remarkably strong joints fast, reliably and at low cost, that has won manufacturer after manufacturer to EASY-FLO use.

Speed . . . reliability and economy are vital to metal joining at any time. Hence, manufacturers who use EASY-FLO will enjoy a distinct advantage in the keen competition that is sure to come with the return to peacetime operations.

If you have not yet tried EASY-FLO, now is the time to find out what it will do for you. BULLETIN 12-A will give you full details. A copy will be mailed to you promptly on request. Write for yours today.

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Included among the parts that are now being produced by this method are long, thin hollow pieces such as shell nosing dies for 90-mm. and 105-mm. shells; tapering and casing dies for the same calibre ammunition and broaching rings for finishing aircraft engine silver lined bearings, rings which must be extremely thin and entirely free from porosity.

After the war it is believed that the process can be adapted for the manufacture of carbide forming dies for turning out such deep-drawn articles as kitchen ware, headlamp shells, etc. The process employs electrical resistance heating for the sintering, and uses a hydraulic press capable of exerting a forming pressure of 100 tons. The press is equipped with water-cooled platens, and is similar to a "press welder."

Heat is supplied through a 750-kva. transformer, and is controlled by G.E. electronic contactors. The molds in which the parts are pressed and sintered are of a graphite-base composition, and are composed of an outer case, an inner core and a ring to squeeze down the carbide powder between them.

The outer case has a flange on the inside to hold the metallic powder in. The density of the finished piece depends on how much powder was used initially.

In machining these graphite base molds carbide tools are used throughout, since the bonding material is highly abrasive. The mold and contents are often preheated in a portable furnace having a controlled hydrogen atmosphere to protect the graphite and molybdenum heating wires.

After preheating, both furnace and mold are removed by a steel cable to directly under the press platen. In hot pressing large die nibs, two pressures are used. At the start, the pressure head travels fast. The final ⅛-in. of movement is under the higher pressure.

—*Modern Industrial Press*, Vol. 6, June 1944, p. 82.

Surface Hardening by Induction Heating

Condensed from "Stahl und Eisen"

The various methods of induction heating possess advantages and economies over flame-hardening methods. In the range between 600 and 10,000 cycles per sec., hardening depths of from 1 to 30 mm. can be obtained, while very thin-walled or pieces of complicated shape require high-frequencies, from 50,000 to 2,000,000 cycles.

The hardening process can either be a total one (the whole surface heated and quenched at one time), or a progressive one (a strip of definite dimensions is heated and the piece passes through the hardening device). Which process to apply depends on shape of piece, kind and extent of hardened zone, electrical energy available and physical conditions of the

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plant. The determining factors are heating capacity and time of heating.

A favorable temperature curve in the piece to be heated is obtained if the ratio of heat input to effective time of heating is such that the heat production in the surface layer is stronger than the conduction of heat away from the surface into the core. The heating of the core may in certain cases have to be taken into account because of the tempering effect exerted in the core.

The danger of coarsening of the grain present in other heating processes is not so great in induction heating, due to the speed of the process. The finer the structure of the steel before hardening, the greater will be the hardness obtained.

The steels best suited for induction hardening in this frequency range are hardening steels with a carbon content of at least 0.3%.

—G. Seulen & H. Voss. *Stahl u. Eisen*, Vol. 63, Dec. 23, 1943, pp. 929-935; Dec. 30, 1943, pp. 962-965.

Electrodeposited Speculum Metal

Condensed from "Tin and Its Uses"

Speculum is the name given to metal mirrors, some dating back to 400 B.C., made of a polished bronze. Although they were ousted from common use in the Middle Ages by the development of the art of silvering glass, they became prominent again in the 18th and 19th centuries as reflectors for astronomical telescopes. At that time massive castings, up to 6 ft. in diam., were made, the metal being about 25 to 40% Sn, balance copper.

The present method of electrodeposition, which gives exact control of composition, has brought about its application to the plating of tableware. Both the reflecting qualities and corrosion resistance of speculum are governed by composition.

Speculum plating of tableware has a special value in wartime because it permits the use of iron as a base metal. Plain steel forks and spoons, when first tried, were obviously in need of a protective coating, and electrotinning was tried. Though serviceable, the resulting plated ware was far from attractive, and speculum was substituted.

The steel base provides stronger and better flatware, while the hardness and tarnish resistance of the speculum plating resists scratching and makes "cleaning the silver" unnecessary. It is more pleasing in appearance than the yellowish tint of the nickel-silver alloys, or the cold bluish cast of chromium. Its cost is much less than that of the electroplated nickel silverware hitherto widely used.

An enormous post-war market at home and overseas is assured by the reaction of experts to the samples already exhibited.

[Ed. Note—The process of electroplating speculum metal is covered by British and American patents.]

—*Tin and Its Uses*, No. 15, Mar. 1944, pp. 8-9.

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Porosity of Electrodeposits

Condensed from "Korrosion und Metallschutz"

The possible causes for porous deposits of electroplated metals were investigated by the hydrogen-charging method of the authors on electrolytic zinc coatings deposited from zinc sulfate solutions. The critical thickness of the zinc coatings, that is, that thickness of the layer below which pores are clearly discernible, decreases with increasing current density and higher pH value of the electrolyte.

The addition of aluminum sulfate, ammonium chloride and an aromatic sulfo-acid, added alone or together, reduces the critical thickness. A buffer effect of the aluminum sulfate addition on the pH value of the cathode film can be clearly observed by the lesser distinguishability of the critical thickness at different current densities and pH values of the bath.

Similarly as in nickel deposits, chloride ions promote formation of hydrogen pores and thus increase the critical thickness considerably for higher pH values. Addition of an aromatic sulfo-acid reduces the critical thickness for low and medium current densities, but increases it again for high current density; the same observation was made also in the combination of sulfo-acid with the other additions. Combined additions reduce the critical thickness more than each individual addition of equal amount.

Particularly thin critical layers are produced with all three substances in the electrolyte.

—H. Fischer & H. Baermann. *Korrosion u. Metallschutz*, Vol. 19, Apr. 1944, pp. 97-101.

Plastic Punches for Metal-Forming

Condensed from "Machinery"

Approximately 2 years ago, the Lockheed Aircraft Corp., Burbank, Calif., commenced experimenting with plastics for drop-hammer and hydraulic press punches used in forming sheets of aluminum alloy, in an effort to find a satisfactory substitute for critical metals. Plastic punches in combination with Kirksite dies are now considered permanent tooling in Lockheed factories.

It is the practice to pour the molten plastic into a finished Kirksite die. When the material has solidified, the plastic punch is ready for immediate use. It is only necessary to scrape a plastic punch at points where the contact between the punch and die may be too close.

The elasticity of the plastic punches enables them to retain their original shape even down to small details, whereas surfaces of small radius on lead punches are generally beaten back to larger radii and reduced heights.

Plastic punches are only one-tenth as heavy as lead ones, and can, therefore, be handled far more easily. Another advantage is that when a plastic punch is brought into sharp contact with the work and the die in drop-hammer operations, only a dull thud is emitted instead of the sharp ringing sound usually produced when both the

heavy duty *Roller Bearings* on this spotwelder mean:

* **LESS MAINTENANCE**
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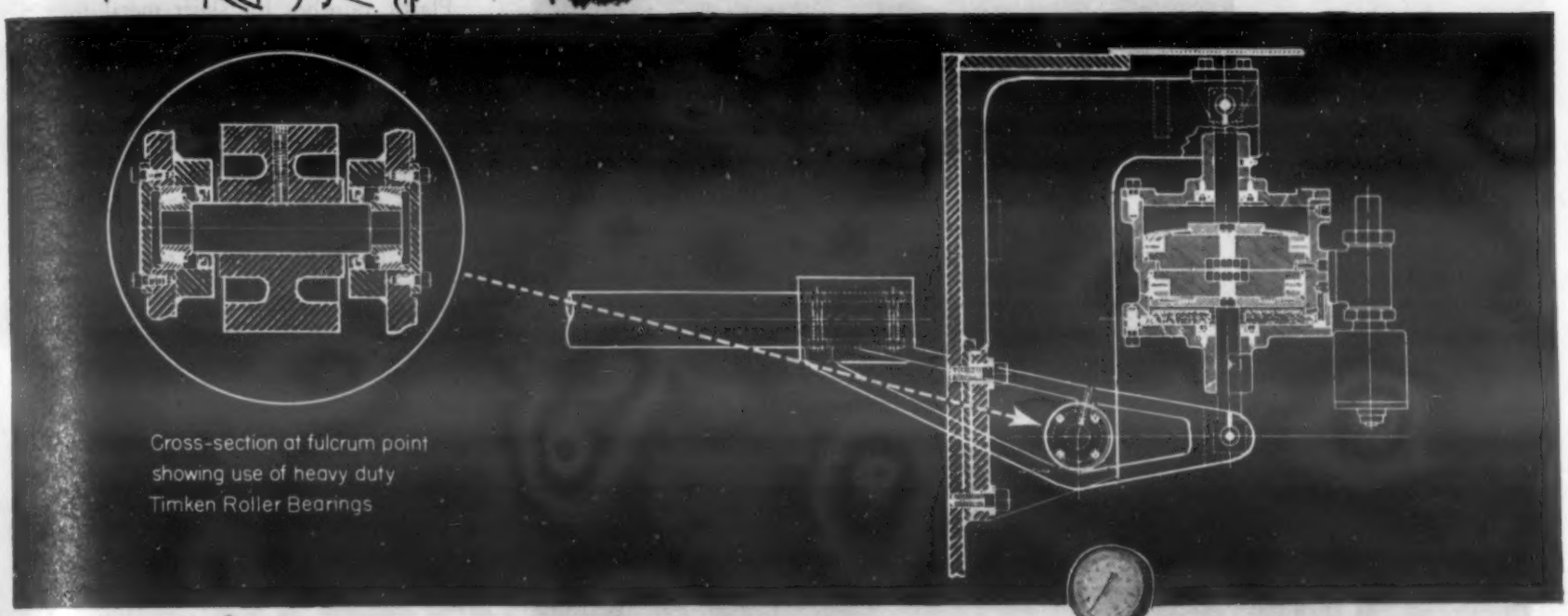
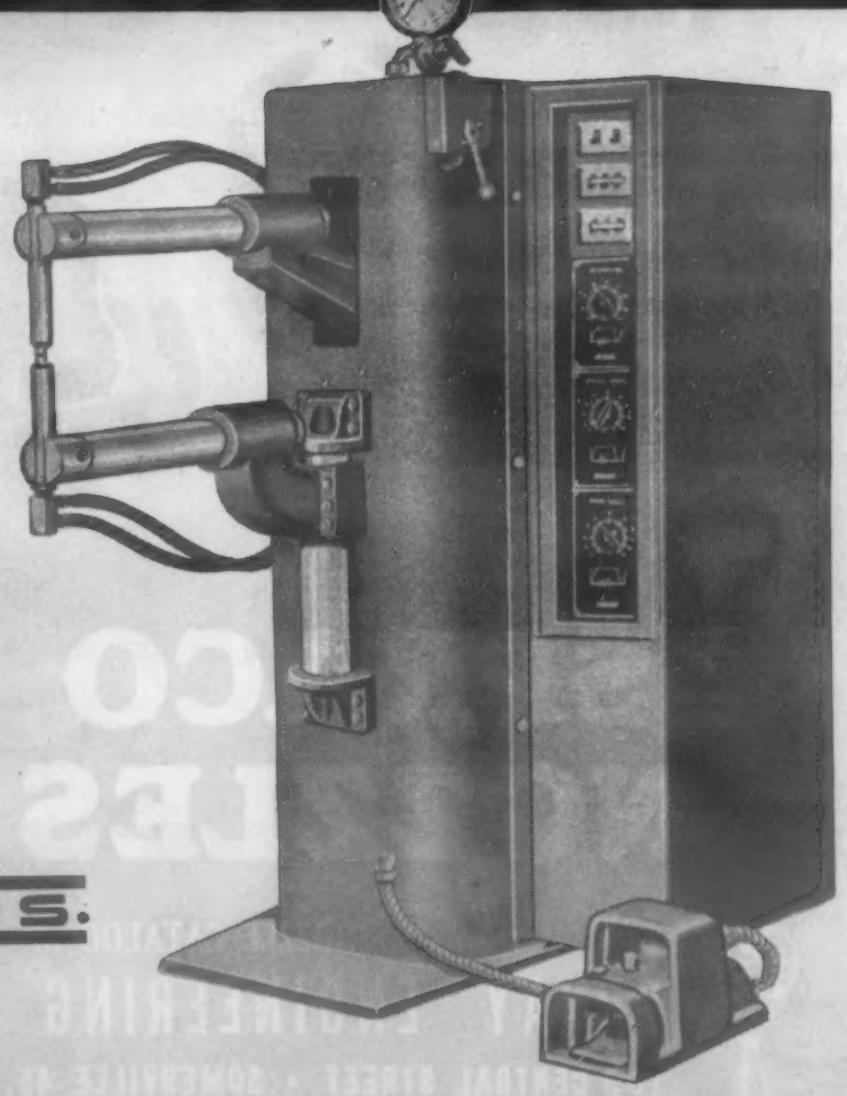


SCIAKY has built into this "small but mighty" rocker arm welder a wealth of features formerly only employed on heavy duty units. The result is a sturdy, accurate, fast machine, perfectly designed for the high quality production welding of light gauge metals.

Heavy duty Timken Roller Bearings at the fulcrum point eliminate wear . . . provide smooth action at maximum pressure. Rubber bumper within the pressure cylinder permits smooth return. Unit is entirely self-contained with controls mounted on a hinged cabinet, convenient to operator.

The machine, type PMCR.0-1 is rated 30 KVA at 100% duty cycle, 50 KVA at 50% duty cycle. Capacity on clean mild steel: up to two thicknesses of .080"; stainless steel up to .040". Speed on two thicknesses of .032" pickled mild steel is 180 spots per minute.

For a more detailed description, write for bulletin 112-A



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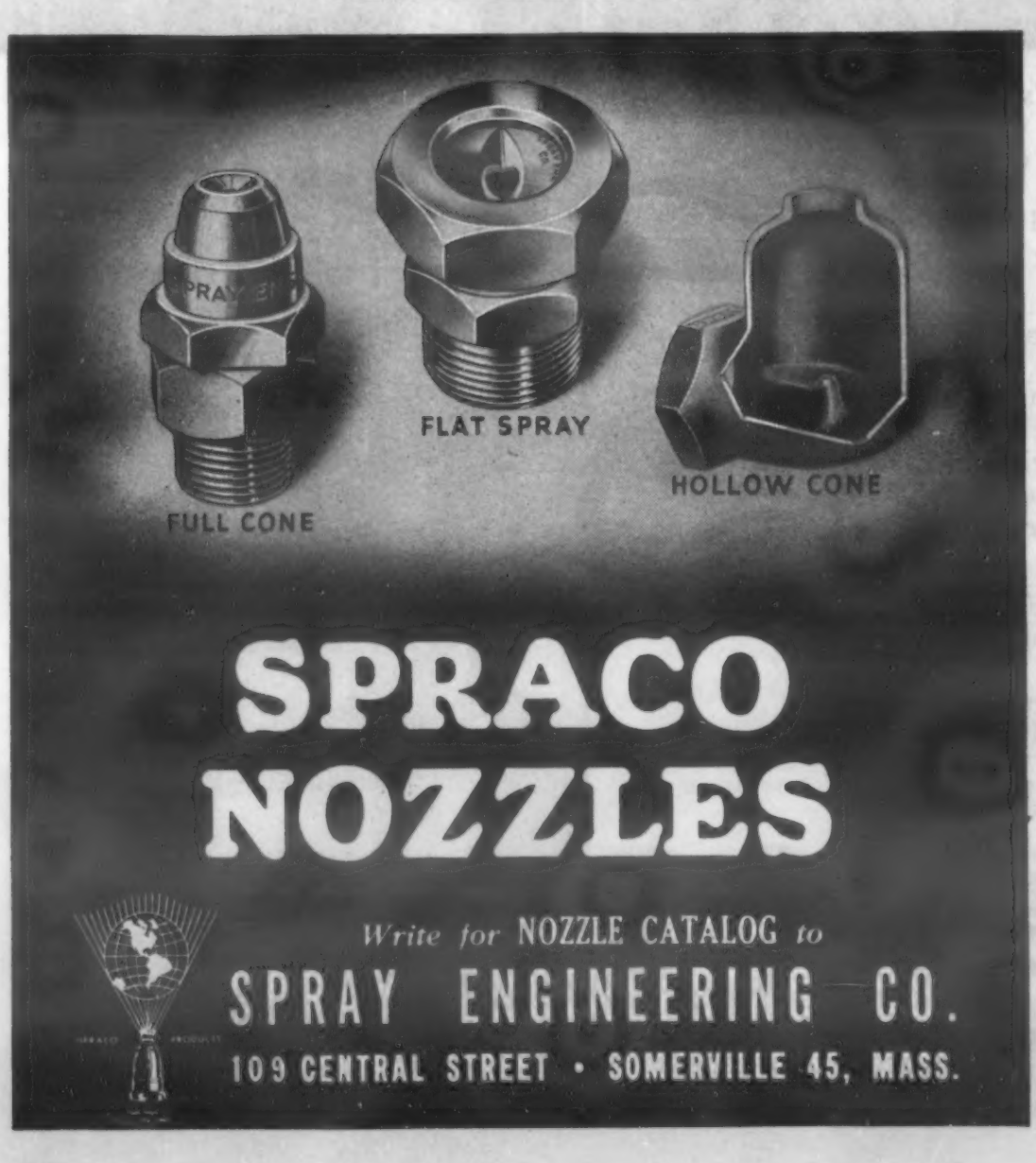

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punch and die are made of metal. This reduced noise also tends to alleviate operator fatigue.

Excellent results have been obtained by casting plastic punches from Nos. 8 and 9 Plastalloy and Tenite II. The Plastalloy is made by the Plastalloy Co., Hollywood, Calif. The No. 8 compound is used for drop-hammer punches and the No. 9 on hydraulic presses. Tenite II is a cellulose acetate-butyrate, made by the Tennessee Eastman Corp., Kingsport, Tenn. Research has proved that either of these plastics may be used for most punches for forming aluminum and its alloys.

Preparation of a Kirksite die for casting a plastic punch is much the same as for casting a lead punch except that it is unnecessary to preheat the die or to spray it with whiting.

Plastic punches for sheet metal forming are obviously still in the pioneer stage, but their increasing application on drop-hammers and hydraulic presses is forecast because the average plastic punch will form parts accurately until such time as the die itself becomes obsolete.

They are used in Lockheed factories as large as 13 ft., 6 in. long by 18 in. wide by 8½ in. thick. A punch of these dimensions weighs about 2000 lb., which seems to indicate that the possibilities for using plastic punches are almost limitless.

—G. H. Prudden, *Machinery*, Vol. 50, July 1944, pp. 136-145.

Temper-Brittleness in Alloy Steels

Condensed from "Archiv Eisenhüttenwesen"

The causes of tempering brittleness (produced by cooling from high tempering temperatures 475 to 575 C. or 890 to 1070 F.) and of hot-embrittlement (produced in the same alloy steel by remaining for longer time at temperatures of 450 to 500 C. or 840 to 930 F.) were investigated, especially in chrome-nickel and chrome-nickel-molybdenum steels. The brittleness was tested by notch-impact tests, which established several facts.

Both phenomena are a kind of cold-embrittlement of the steel at low temperatures. They come about in alloy steels by remaining for longer time in a critical temperature range whose location depends on the duration of tempering and the chemical composition of the steel, particularly frequently at 400 to 550 C. (750 to 1020 F.).

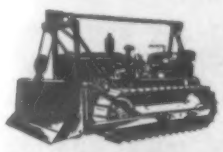
Temper- and hot-brittleness can be suppressed by alloying the steel with such elements which prevent shifting of the cold-brittleness towards higher temperatures, *e.g.*, a molybdenum addition to chrome-nickel steel.

A reduction of the tendency to hot-brittleness can also be obtained by holding the chrome-nickel steel for at least one day at high annealing temperature, up to 650 C. (1200 F.), if this heat treatment can be expected to prevent the shifting of the cold-brittleness temperature ranging towards room temperature.

—P. B. Mikhailevmikhejev. *Arch. Eisenhüttenw.*, Vol. 17, Jan.-Feb. 1944, pp. 177-184.

HARD and FAST
TOCCO equipment for "Caterpillar" roller hardening and shrink-fitting. Duplicate installations are at Caterpillar Tractor Co. and American Car and Foundry Company.

TOCCO *Shrink-Fits* AS IT HARDENS TRACTOR ROLLERS



The part shown above is a 90-lb. track roller assembly of the D-7 Caterpillar Diesel Tractor—a rugged war machine, famous on battlefronts the world over. This roller assembly . . . like many other "Caterpillar" parts . . . is TOCCO-treated for uniform high quality and speed of production.

At one push of a button, a TOCCO machine . . . of special design for this specific job . . . performs these three functions speedily, automatically timed to split-second accuracy:

1. TOCCO induction heats the rims of two rollers simultaneously, while the rollers rotate, assuring a uniform amount and depth of heat. Total heating time: 2 min., 15 sec.
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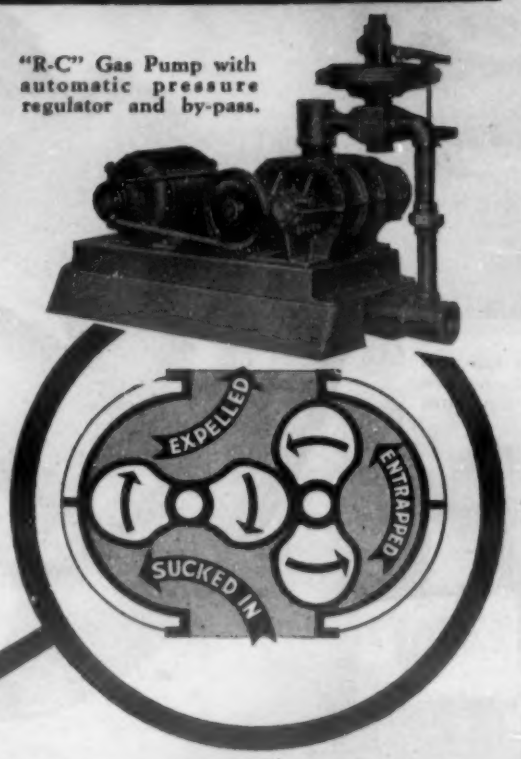

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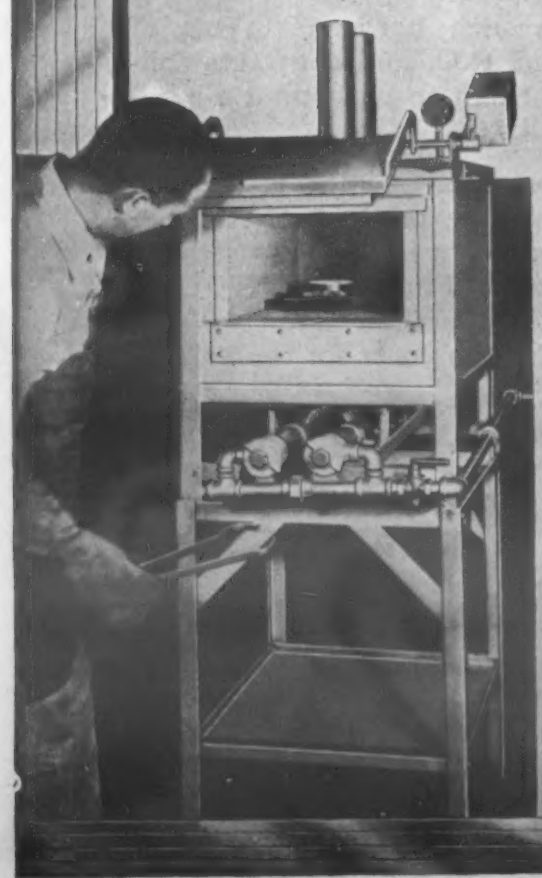

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Black Stainless Steel Coatings

Condensed from "Metal Finishing"

Chemical and electrochemical processes commonly used for blackening steels have not proved satisfactory for stainless steels. A suitable method for directly blackening stainless steels is desirable because of the necessity for using a non-reflective surface in many armament parts.

Various methods which have been employed are the application of pigments, enamels, japans, electroplated coatings, by tempering, etc. None of these coatings is entirely satisfactory, either because of brittleness, poor adhesion, low resistance to wear or abrasion, or because of poor corrosion resistance.

A method has been developed that produces a black oxide coating on stainless steels that is free of the above shortcomings. In this method, the articles to be blackened are first cleaned to free them of scale, grease, oil or dirt. After drying, they are immersed for a sufficient length of time in a bath of molten dichromates, preferably sodium dichromate, at a temperature in excess of 615 F.

The parts are then removed from the bath, allowed to cool, and immersed in warm water. Treatment time depends on the bath temperature, and on the size and number of the parts being treated. Immersion time is 15 to 20 min. at the recommended temperature of 730 to 750 F.

The only equipment necessary is a steel tank and a source of heat. A cover and provision for stirring the melt are recommended. Occasional shaking of small parts in baskets will insure a more uniform finish.

The coatings produced by this method have a permanent black color, and exceptional strength and elasticity. A stainless steel wire (18-8) of 0.150 in. diam., after blackening as above, was drawn to a 10% reduction in cross-section with no visible break in the coating.

The corrosion resistance in various media, *e.g.*, boiling dilute nitric acid, and hot dilute hydrochloric acid, is much better than that of uncoated stainless steel.

—Irvine Clingan. *Metal Finishing*, Vol. 42, Mar. 1944, pp. 139-140.

Heat-Bonding Metal Powders

Condensed from a Paper of the Electrochemical Society

This study was undertaken to determine the effect of various factors on the extent and nature of the bond formed when loosely packed metal powders are heated to different temperatures.

Two kinds of iron powder were used, carbonyl iron and electrolytic iron. The carbonyl iron particles are smaller and spherical, while the electrolytic iron particles are flaky. A fixed weight of the powder was placed in a Zircofrax or silicon boat, leveled and sintered in a resistance furnace in an atmosphere of dry hydrogen.

Microscopic examination revealed that with carbonyl iron the extent of bonding and grain growth increases continuously as

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The problem was to remove various types of oil, grease and solvents from steel drums—and to strip paint from these containers. The operation was carried on continuously in a 1000-gallon drum washer at 145 to 155 degrees Fahrenheit.

Several kinds of commercial cleaners had been tried previously, but cleaning was not satisfactory, rejects ran too high and costs were out of line. The method in practice was the use of an initial charge of 400 pounds of cleaning compound, followed later by an additional 300 pounds.

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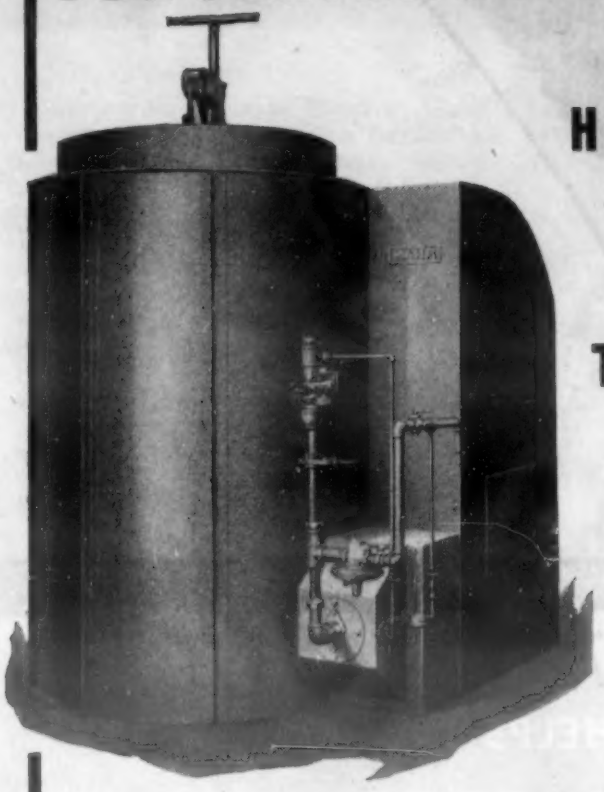

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the temperature is increased from 300 to 1300 C (570 to 2370 F.). From 300 to 500 C. (570 to 930 F.), bonding is slight and the product is fragile. At 900 C. (1650 F.) the specimen has almost the same appearance as massive metal. It is porous, but the cavities are much smaller than in the specimens heated to a lower temperature. Cracks are visible.

At 1000 to 1300 C. (1830 to 2370 F.) the porosity increases and the grains become very large. The samples sintered at 1300 C. have increased density (5.3 g./cc.), but the individual pores are larger than in some specimens sintered at a lower temperature.

Electrolytic iron powder, both annealed and unannealed, bonded to a smaller extent than carbonyl iron powder heated to the same temperature. Even after heating to 1300 C., most of the original particles are still visible, though some bonding has occurred.

Particle size has little effect on the temperature at which electrolytic iron powder begins to sinter, but is an important factor in the extent to which bonding proceeds once it has started. A specimen of the coarsest fraction sintered at 1300 C. was very fragile compared with the finest fraction specimen.

Addition of 0.1 and 0.5% of graphite to the finest fraction of the electrolytic powder appears to lower the temperature at which grain growth and bonding start, but the evidence is not sufficient to warrant a definite statement. It appeared from a limited number of experiments that cold working of the electrolytic iron particles favored bonding.

The bonding of carbonyl iron particles rendered flaky by ball-milling was tested. At the higher temperatures bonding took place to a large extent. The shrinkage was very great, and the final porosity was greater than with spherical carbonyl iron, both effects due largely to the lower apparent density (looser packing) of the original flaked carbonyl iron powder. This variable makes it difficult to interpret the effect of particle shape on bonding.

Fine copper shot was used for the experiment with copper. Two fractions were employed, —50+100 and —200 mesh. Results were similar to those obtained with iron. The coarse fraction remained weakly bonded after heating to 1050 C. (1920 F.), and the original particles were almost unchanged.

Samples made from the fine fraction were quite strong. In specimens sintered at 1050 C. the original particles could not be seen and the porosity was low.

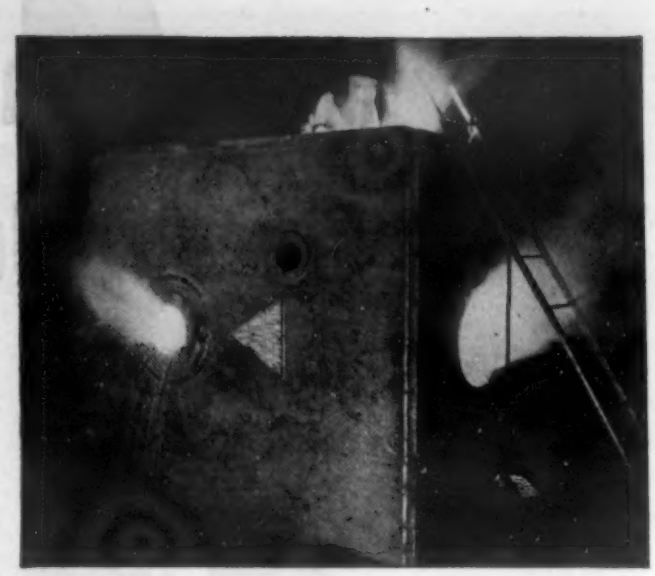
Silver shot was used for the experiments with silver. Two fractions, —16+40, and —40+50 mesh, were sintered at 900 and 950 C. (1650 and 1740 F.). Specimens made from the finer powder were stronger, but all were fragile.

Following are some of the practical applications of sintered metal powders that have not been pressed: (1) filters; (2) impregnated materials; (3) articles fabricated by coining or other forming processes; and (4) use in articles in which the low apparent densities of these sintered metal powders may have advantages over high-density metals.

—Laurence Delisle, *Electrochem. Soc.*, Apr. 1944 meeting, Preprint No. 85-16, 10 pp.

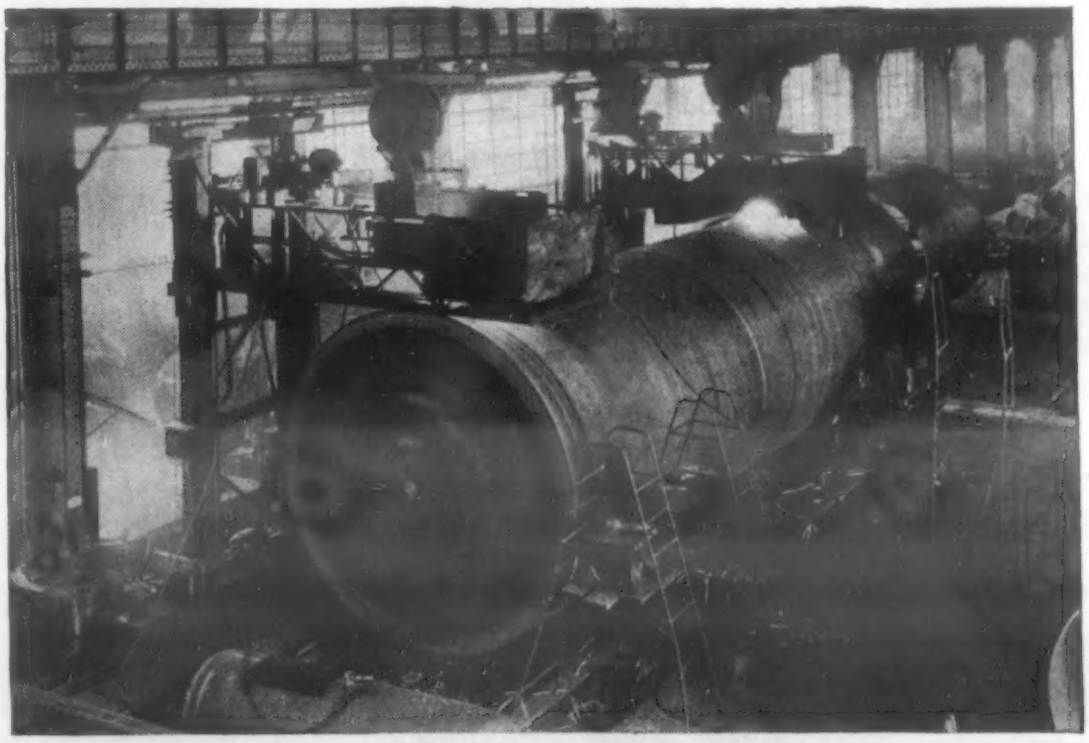
AUTOMATIC WELDING has many advantages in fabricating boiler drums, cracking stills and other products for which repetitive welding is practical. Deposit rate is often greater because of the use of higher currents, and a larger ratio of welding time to working time, compared with manual welding. The strength and high quality of the weld are due to the close control of the arc and the excellent fusion possible at high currents using Murex Electrodes.

Murex rods available for automatic welding are Type F, Carbon Moly. 50 and Cromansil. The spiral asbestos winding of these rods anchors the coating to the core wire so that the electrodes may be coiled without cracking and also provides an absolutely concentric coating that does not spawl off under the slitter.



THIS STRIKING action photograph illustrates the use of Murex Electrodes in welding the top member of a single action, single eccentric press, fabricated by Clearing Machine Corporation. Press frames are positioned with only four turns. The sides weigh from 80,000 to 90,000 lbs. and some plates are 10″ thick. Double-Vee welds, back-stepped, are employed.

HUGE PRESSURE VESSELS over 6′ in diameter, up to 35′ long and having a shell thickness of 4″ to 5″ are welded automatically by Foster Wheeler Corporation with Murex Type F and Carbon Moly. 50 electrodes in continuous coils. The soundness of the weld metal is shown by the fact that as many as 44 longitudinal boiler drum seams have been welded consecutively, with only five minor defects showing up under X-ray examination.



CRANE GIRDERS are subject to severe overloads and the shock of sudden stops and quick reversals. Manning, Maxwell & Moore, Inc., applying a special technique, uses Murex Electrodes in the construction of its "Shaweld" crane girders. They are much stiffer laterally than riveted girders and more resistant to the twisting motion set up by the driving machinery. Positioning cradles are used to permit downhand welding on the girders which are exceptionally long and heavy.

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4 Materials and Engineering Design

Engineering Properties of Metals and Alloys • Resistance to Corrosion, Wear, Fatigue, Creep, etc. • Engineering Design Problems of Specific Industries and Products • Selection of Metals, Metal-Forms and Fabricating Methods • Non-Metallics in the Metal Industries • Applications of Individual Materials • Conservation and Substitution

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Welded Steel Structural Members

Condensed from a Bulletin of the University of Illinois

The engineering experiment station of the University of Illinois conducted an investigation of the fatigue strength of fillet-weld and plug-weld connections in steel structural members. The material in most of the structural members tested was carbon steel of structural grade, corresponding to A.S.T.M. A-7.

It was shown that, of the various types of fillet-weld joints connecting plates, none had a significantly greater fatigue strength than the simple joint with longitudinal fillet-welds along the sides and transverse fillet-welds along the ends of the plates. Three joints of this type withstood an average of 283,000 cycles in which tensile stresses varied from 0 to 18,000 p.s.i.

The fillet-weld joint with longitudinal welds along the sides and transverse welds across the ends of the channels had the greatest fatigue strength, three joints averaging 849,000 cycles with tensile stress varying from 0 to 18,000 p.s.i.

Channel box sections connected to gusset plates gave lower strengths than for two channels back-to-back with a gusset plate between. The fatigue strength for welded channel box sections was approximately the same as for riveted connections.

For lateral connections, fatigue strength values were much more erratic for riveted angles than for welded angles or welded channels, and minimum values were less. Angles and channels both eccentrically connected with fillet welds, showed no significant difference in fatigue strength. Channels with longitudinal and transverse fillet welds and relatively large eccentricity had 20% less fatigue strength than channels with butt welds and no eccentricity.

Failure of the specimens with longitudinal fillet welds occurred in the main member and at the end of the weld toward the center of the specimen. No welds failed. Specimens with butt welds failed in the channel at the junction with the weld, where abrupt change in section caused a large stress concentration. Riveted angles failed at the inner rivet hole and on the side away from the outstanding leg.

Peening increased the fatigue strength of transverse fillet welds and decreased that of longitudinal welds. It was impossible to determine whether the difference in fatigue strength was due to peening or to some other cause.

For plug welds, the fatigue strength in shear, based upon the nominal diameter of the plugs, and for 100,000 cycles, was of the order of 20,000 to 25,000 p.s.i. Fatigue strength of the plugs showed a small but consistent increase with increase in thickness of the outside plates, and a slight but not always consistent decrease with increase in diameter of the plugs. The pattern of the plugs in multiplug joints did not appreciably affect the fatigue strength.

For plates connected by plug welds, fatigue strength was somewhat greater for the outside than for the inside plates, the outside plates having 26,000 to 30,000 p.s.i. for failure at 100,000 cycles, the inside 25,000 to 27,000 p.s.i.

While the unit fatigue strength was approximately the same for fillet-weld plugs and filled plugs, that of the outside plates of a plug-weld joint was significantly less for fillet plugs than for filled plugs.

Attachments either welded or riveted to a continuous plate reduced the fatigue strength of the plate, the magnitude of the reduction depending upon the geometrical characteristics of the attachment and the physical properties of the steel.

—*Univ. Ill. Eng. Exp. Station*, Bulletin No. 30, Vol. 41, Mar. 14, 1944, 94 pp.

Lead-Alloy Cable Sheath

Condensed from "Bell Laboratories Record"

Trials in the field are needed to supplement laboratory tests of telephone cable sheath before much can be said about the usefulness of a new alloy. The crystalline structure of these alloys continues to change, sometimes for years after being placed in service.

Laboratory tests of lead-calcium alloy sheaths showed outstanding resistance to fatigue, but an experimental outdoor instal-

HIGH FREQUENCY PREHEATING

...in the molding of plastics

■ This message has one idea...to emphasize wartime progress in molding methods which enlarge the field for Durez compounds. In the post-war period, high frequency preheating, along with many other new developments, will provide your custom molder with the means for making his service even more appealing than ever before.

The use of high frequency preheating in the molding of phenolic materials has opened up a completely new field especially in heavy duty materials that is a *natural* for Durez compounds. The principal advantages of this method consist of (1) a reduction in the molding time cycle and (2) a better molded product with greater density, improved electrical properties and a more uniform cure.

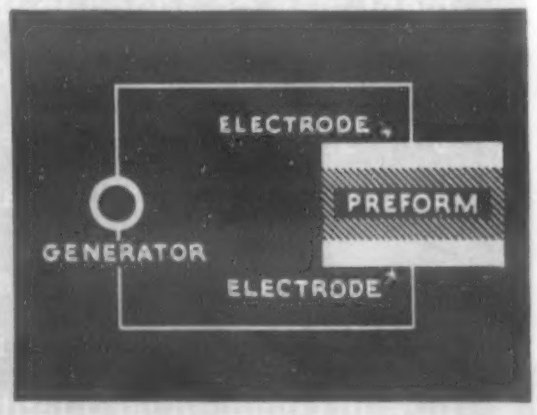
The illustration at left serves as an excellent example of the successful application of high frequency preheating in the production of a molded plastic part. The item pictured is a terminal board for military use which was molded from a preform of high-impact macerated-fabric-type Durez phenolic molding compound.

The basic operation of all high frequency preheating is shown in the simple diagram at right (notice the preform in position between the high frequency electrodes). Since the preform is never a perfect non-conductor, some leakage takes place through it. This leakage current manifests itself in the form of heat and thus the preheating of the preform takes place quickly and thoroughly. This method of preheating is particularly valuable when the preforms are of unusually thick, heavy duty material.

The use of high frequency preheating in the molding of plastics is still in the process of development and therefore is extremely limited at the present time. However, the fact that its usage results in a reduction of the molding time cycle and a better product, seems to indicate that it can be viewed as one of tomorrow's certainties.

This is but one of many developments in which Durez phenolics fill the bill. Because of their excellent dielectric properties, inertness to solvents, resistance to impact, high heat, climatic changes, mild acids and alkalies, Durez versatile phenolics have found a place in practically all fields of industry.

Perhaps there is some question in your mind about the inclusion of plastics in your post-war plans. Why not get a competent answer to that question now? Our staff would welcome the opportunity to discuss any plastic material problem with you. Durez Plastics & Chemicals, Inc., 99 Walck Road, North Tonawanda, N. Y.



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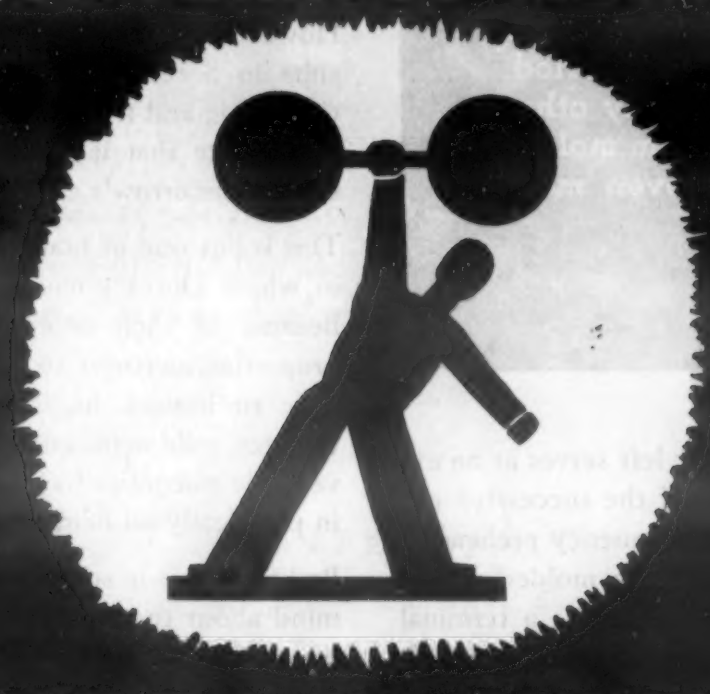

The white and red metals, long handicapped for many purposes by their softness and ductility, acquire new strength and hardness through addition of INDIUM in small amounts. This new "vitamin" element may be added in the melt as part of the alloy, or may be plated on and diffused into the surface, giving remarkable benefits in the form of surface hardness, finishability, and corrosion resistance.

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lation was required to determine the effects of time and weather. In this way the relative importance of expansion and contraction due to temperature change, scratches, ring-chatter marks, ring-scores due to wind vibration, and methods of repair were studied.

Studies indicated that method of installation was important. When the cable had been placed and spliced during winter weather, while the strand from which it was suspended had been installed under excessive tension, the lesser expansion of the steel strand caused an excess of cable, and more rapid cable failure.

Ring scores, ripples, and buckles have been responsible for most of the failures. Gradual formation of ripples along the concave side of bowed cables, where compression was greatest, was noticed. Sheaths of lead-calcium alloy did not ripple as badly as those of lead-antimony, but were more susceptible to fatigue failure at shallow circumferential cracks. Even shallow scratches seemed to have a considerable effect due to stress concentration.

With the lead-antimony sheath, failures originating at the ripples showed a granular appearance of the metal, and fine cracks.

—F. B. Livingston. *Bell Labs. Record*, Vol. 22, June 1944, pp. 441-444.

Thorium-Bearing Steels

Condensed from "Archiv Eisenhüttenwesen"

Thorium does not produce a separated gamma range in the system with iron. There exist very likely several compounds of iron with thorium of which one thorium-rich melts a little above 1000 C (1830 F.), while the others have very much higher melting points. A strong solubility of one of the two metals in another state than the solid is improbable.

The effect of thorium in amounts up to 1.4% on hardening steels consists mainly in the formation of a very stable carbide ThC_2 which even at temperatures up to 1340 C. (2440 F.) is practically insoluble in solid iron.

The hardening temperature range is, however, not much enlarged, as the thorium carbide exists mainly in coarse distribution. The hardenability of steels is, therefore, entirely lost if the thorium content reaches about 10 times that of the carbon content, which is sufficient to bind the total carbon content as carbide.

Larger amounts of thorium in the hardened steel reduce its toughness. Contrary to alloys for heating elements, the scaling resistance of hardening steels is not improved at 650 and 800 C. (1200 and 1470 F.) by alloying with thorium. The experiments made lead to the conclusion that an addition of more than a few tenths per cent thorium is rather a disadvantage than useful.

Thorium seems to be able to prevent intercrystalline corrosion of austenitic steels if it can be had at sufficiently low price and in sufficient quantities.

—H. Cornelius. *Arch. Eisenhüttenw.*, Vol. 17, July-August 1943, pp. 23-27.

POMET POWDER METALLURGY

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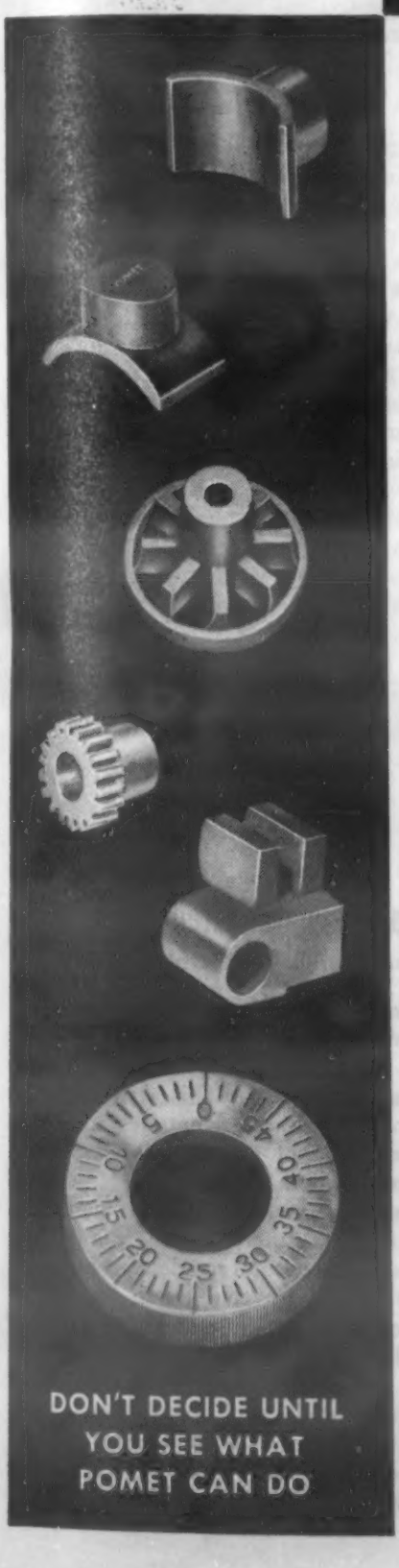

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Pomet produces parts of specified density with the same exactitude that you would expect in the control of porosity for oil-less bearings.

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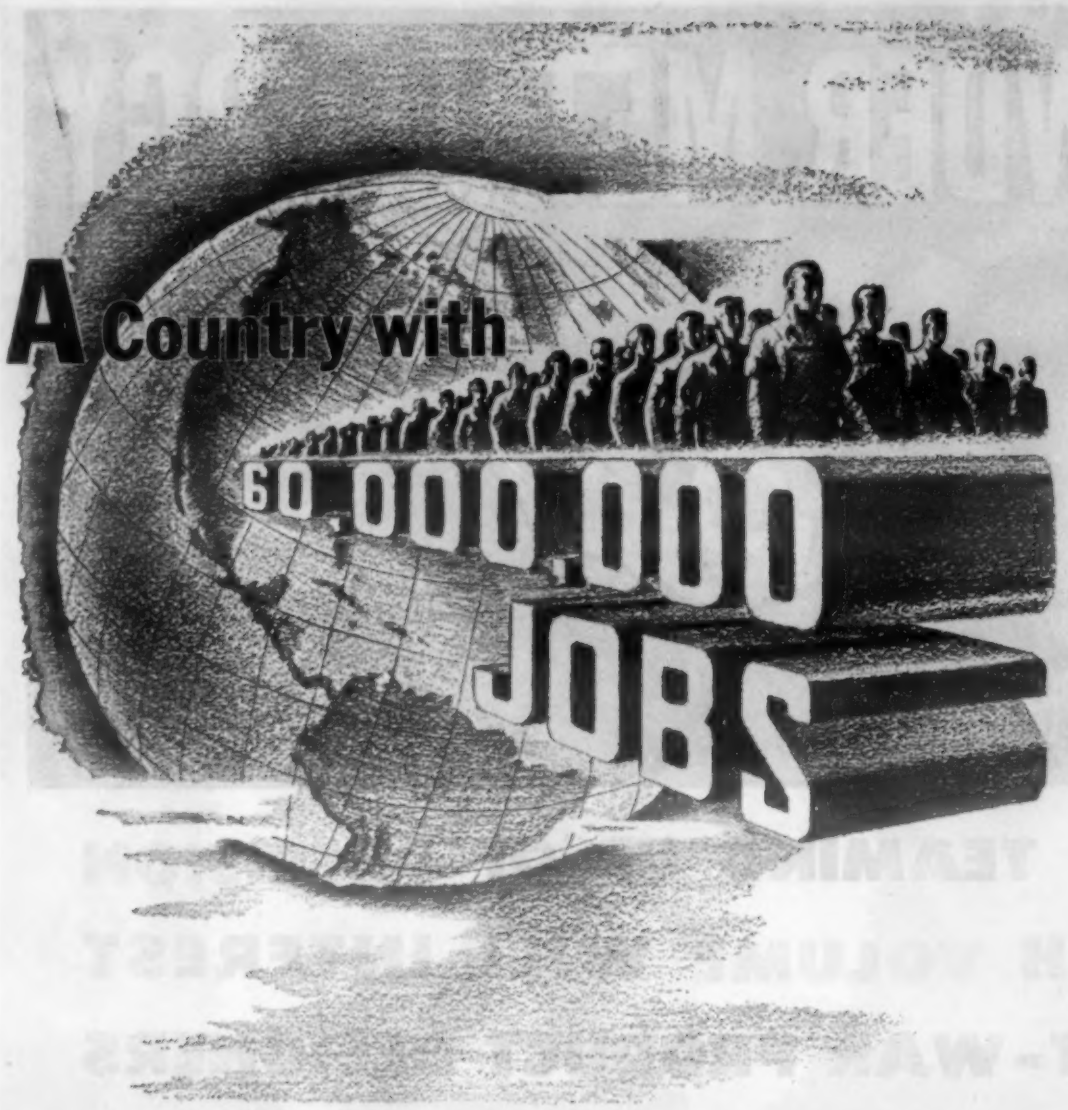

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Welded vs. Riveted Joints

Condensed from "Metal Treatment"

Riveted joints have over a century of experience behind them, and the accumulated experience and skill of generations of boilermakers have given confidence in the principles of design that have been evolved. A great advantage is that a defective riveted joint immediately gives evidence of its condition by leaking under hydraulic test or in service.

However, the static strength of a lap joint with a single row of rivets is only 57% of that of the original plate, and even a butt joint with 2 cover plates and 4 rows of rivets has an efficiency of only 94%. The fatigue strength is of the order of 52% of that of the plate. On the other hand, well-made welded joints may be stronger than the original plate, and the fatigue strength of butt welds 50 to 85% of that of the plate. Fillet welds may be much weaker in fatigue, particularly if the fillets are too small or the surface finish is poor.

Freedom from both external and internal defects is vital, and external irregularities should be removed by machining or grinding.

The practice of attempting to strengthen riveted joints by welding may be a risky proceeding, and there is a great danger that before the necessary movement to distribute the load on the riveted portion can occur, the whole of the load will have been taken by the welded portion.

Some authorities consider this difficulty may be overcome by placing the riveted joint under load before welding, but the welding stresses themselves may introduce complications. Further, local rigidity introduced by welding may cause rapid fatigue failure. Nevertheless, in the case of bridges that need strengthening or that contain corroded members which need replacing, welding has often been used satisfactorily.

—J. Dearden. *Metal Treatment*, Vol. 10, Winter 1943-1944, pp. 207-210, 232

Plastic-Impregnated Wood

Condensed from "Aero Digest"

Methylolurea is a chemical, developed by the duPont company, that is used to impregnate wood and give it entirely new and desirable qualities. This water-soluble resin-forming chemical penetrates into the cellular structure of the wood, forming a "transmuted" wood.

The process makes lumber markedly harder, stronger, stiffer, and more durable. It eliminates its natural tendency to swell, shrink, or warp with changes in humidity, and prevents the grain from rising when moistened.

Doors, windows and drawers made of it will not swell, stick or contract and become loose. Furniture made of it can be shipped into any climate. It makes wood as strong as steel in certain machinery parts. It enables industry to create in a

Your customer recognizes a promise of superior performance . . . when he reads

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When you specify *and mention* parts of Ampco Metal, your sales department gains the advantage of *two* reputations — yours, and Ampco's. Ampco Metal is widely used, widely known, and widely advertised throughout industry — for critical parts subject to wear, impact, fatigue, corrosion, etc.

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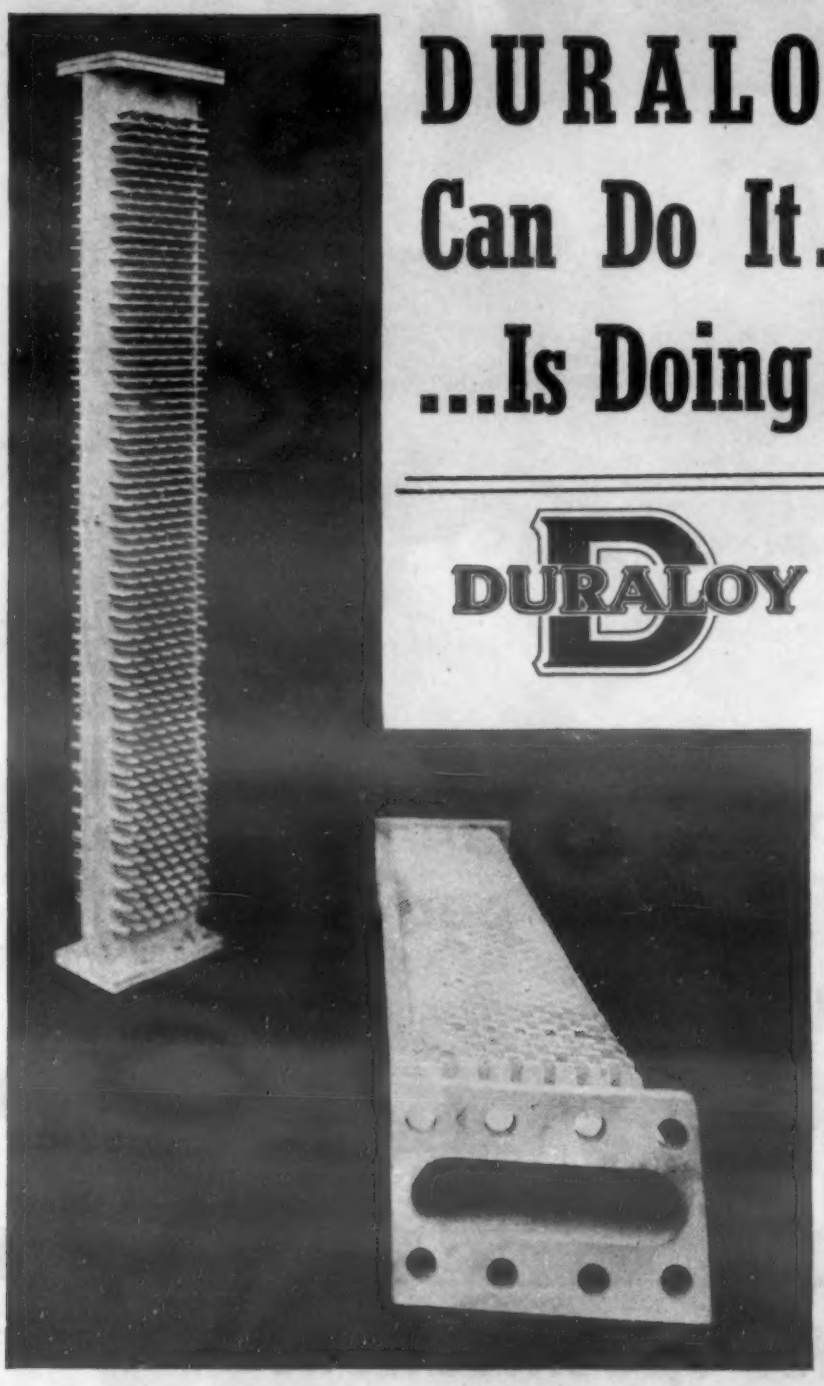

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few days woods harder than ebony, which nature takes a century to grow.

Cheaper woods can hereafter compete with the rarer and more expensive woods. It can be applied to large structural timbers as well as smaller items.

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It is prepared merely by dissolving urea and dimethylolurea in water. Both are produced from ammonia, carbon dioxide and methanol, which are synthesized from coal, air and water. Urea results from the reaction of ammonia and carbon dioxide.

Formaldehyde, which is derived from methanol, condenses with urea to form dimethylolurea. Urea and dimethylolurea are commercially available, inexpensive products.

—*Aero Digest*, Vol. 45, May 1, 1944, pp. 104.

Damping Capacities of Metals

Condensed from N. E. Coast Institution Engineers & Shipbuilders

This paper gives the results of further study on specific aspects of the subject referred to in the discussion of the earlier paper (see METALS AND ALLOYS "Engineering File Facts," Number 50, June, 1944, pp. 1435, 1437).

Experiments were made to determine the effect of various conditions of test. The application of a relatively large number of impulses caused no systematic changes in damping capacity. Tests carried out in vacuo and in a 3:1 hydrogen air mixture indicated that any contribution of air-damping to the damping capacities recorded may safely be neglected.

Variations in temperature of the order of those encountered in normal fluctuations of room temperature were found to be very important with 0.12% C steel (an increase of 59 F. increased the damping capacity by 60 to 90%, depending upon stress), quite marked with an austenitic alloy, and unimportant with stainless iron or stainless steel.

The consistency of results from a number of samples from the same bar of 0.12% C steel was found to be very good. However, when samples were tested from three heats, each of various grades, the reproducibility was not as clearly marked although the results were, in each case, characteristic of the material. Variations in surface finish did not affect damping capacity within the limits of error.

No effect of service was found that was outside the limits of experimental error in tests on samples from a fan shaft that had been in service for 30 to 40 yr. or in continuous tests, extending up to a week, on three steels.

Damping and Carbon Content

Fairly good correlation was obtained

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The Brown Instrument Company found a means to faster thermocouple response—and better temperature control—in protection tubes of VYCOR Brand Glass No. 790.

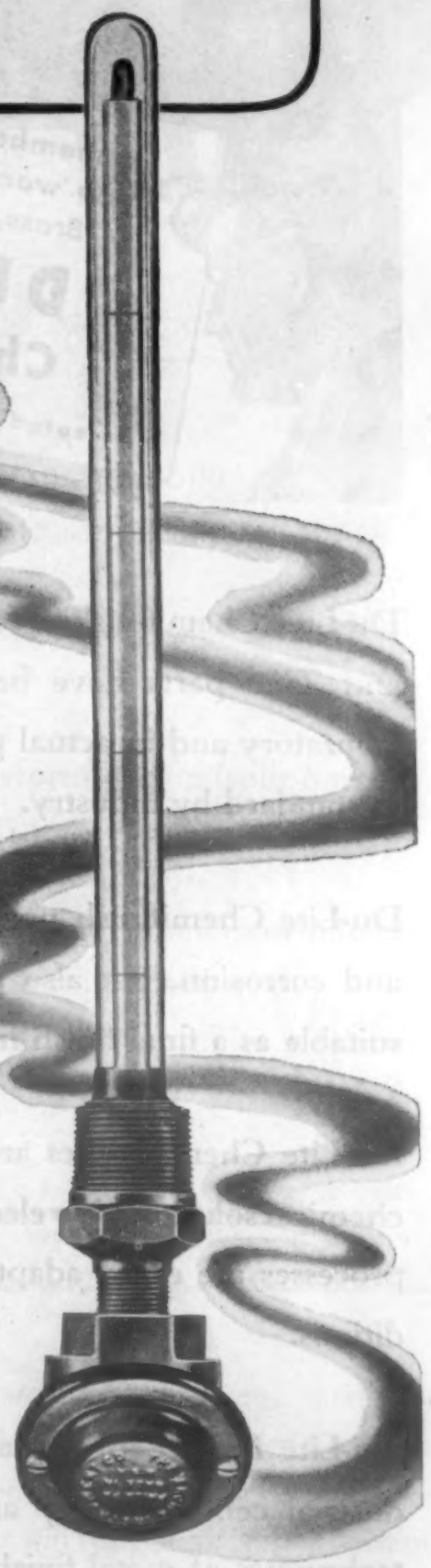
Heat radiates directly to a thermocouple through a transparent VYCOR protection tube. It reaches the thermocouple nearly as fast as if there were no protection tube present. Hence, the thermocouple registers quickly any changes in temperature—approximately three times as fast as a thermocouple shielded by an opaque tube.

And VYCOR Brand Glass No. 790 also provides better protection for thermocouples—because, unlike metals, it is impervious to corrosive furnace gases even at high temperatures. Furthermore, because of the heat resistance and corrosion resistance of this glass, the service life under many conditions is longer than that of metal tubes.

In view of the faster response and better protection for thermocouples, it's no wonder that the Brown Instrument Company has adopted VYCOR protection tubes for many applications.

Here is just one more case where VYCOR Brand Glass No. 790 has been able to solve a difficult problem. And VYCOR Brand Glass No. 790 is just one of the Industrial Glasses by Corning that are at the service of product designers.

For the properties, forms available and typical practical designs get the new bulletin—just off the press—on "Industrial Glass by Corning." Write today for your copy. Address Industrial Sales Dept., MA-9 Corning Glass Works, Corning, New York.



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Du-Lite Chemifinishes for blackening Steel, Brass, Copper, and Zinc parts have been thoroughly tested both in the laboratory and in actual production. They are now accepted as standard by industry.

Du-Lite Chemifinish not only provides protection from rust and corrosion, but also produces an attractive black that is suitable as a final finish in most cases.

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between damping capacity and carbon content, the degree of correlation being highest on samples obtained from approximately the same size bar and in the same condition of heat treatment. Typical results for a series of normalized samples were:

%C	% Damping Capacity at a Stress of 4,480 p.s.i.
0.12	2.02
0.19	1.48
0.33	0.77
0.39	0.60
0.51	0.41
1.32	0.41

The effect of variation in chromium content was also investigated:

%Cr	%C	Heat Treatment	% Damping Capacity at a Stress of 4,480 p.s.i
2.16	0.23	oil quench +	0.53
5.39	0.23	temper at	1.16
8.50	0.24	1290 F., air	2.32
11.44	0.26	cool	2.24
14.55	0.26	1380 F., air	3.97
16.92	0.12	cool	1.56
20.87	0.26	1380 F., water	1.61
33.19	0.26	quench	1.92

The four lowest chromium steels, all of which exhibited the same type of microstructure, showed an increase in damping capacity with increasing chromium up to 8.5%, the values for the 9.5% and 11.44% Cr. steels being identical within the limits of experimental error. The high values for these last two steels indicate that the well-known high values recorded for stainless irons and steels are not anomalous, but are dependent on the composition of the material or on some other factor which itself varies with composition.

A series of tests on the effect of nickel (all samples slow cooled from 1560 F.):

%Ni	% Damping Capacity at a Stress of 4,480 p.s.i.
5.05	0.54
20.40	0.45
30.20	0.40
35.71 (natural)	1.35
45.77	2.62
68.20	2.12
79.08	0.86
79.7	0.78
89.90	0.62
99.4 (as rolled)	10.24

Effect of Magnetism

Magneto-striction was also investigated. There is a clear correlation between the damping capacity and the mechano-magnetic properties which suggests the significance of magnetic contributions to damping capacity. The exceptionally high damping capacity of nickel is to be noted.

Although nickel and 25 Cr-20% Ni alloy have a similar structure, the damping capacity of the former is about 20 times as great. The facts that slightly magnetic high alloy steels of related types show higher damping capacities than the 25 Cr-20% Ni type and that nickel is ferromagnetic are believed further indication of the inter-relationship of magnetic properties and damping capacity.

Examination of cracked and crack free forgings showed in all cases higher damping capacity values for the cracked specimens (for example, 1.10% damping capacity at

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Frontier Alloy 40-E

and Offers

Shock Resistance — Tests have proved its exceptional ability to withstand explosive shock and standard impact shock.

Corrosion Resistance — Excellent, not only in standard corrosion tests but also under stress.

High Yield Strength — A dominant factor where distortion or misalignment of parts would make the assembly inoperable.

Machineability — Far superior to the usual sand cast aluminum alloys and machined parts have a high lustre.

Pressure Tightness — The fine grain of the alloy enables it to withstand high pressures.

Specifications . . . Army-Navy Aeronautical Spec. AN-A-17; U. S. Navy Spec. 46A-1 (INT), Class 1; A. S. T. M. Spec. ZG-41, alloy O.

Typical Physical Properties . . . tensile strength, 35,000 psi.; yield strength, 25,000 psi.; elongation, 5% in 2".

ENGINEERING Data on Request

Handy Alloy Data Book, containing metallurgical and engineering data, now available. Write for your free copy, stating your name, title and address.

● Foundries from coast to coast are now "40-E" licensees. Increased demand for "40-E" castings has required an increased production of this new alloy and necessitates the licensing of additional foundries. Your request for complete licensing data will receive prompt attention.

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HAVEG

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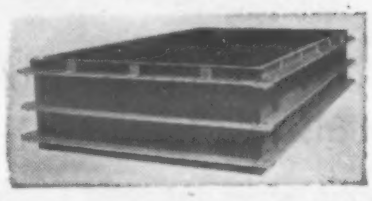

HAVEG is a molded plastic which is unaffected by acids, alkalies, and chemicals generally. It is *not* a lining or coating but is resistant throughout its entire mass.

Rectangular Tanks as large as 12 feet long are made in seamless one-piece units. These tanks are made in standard sizes in which the outside dimensions are multiples of 6". This standardization permits the production of an almost unlimited number of standard sizes in which no single dimension will vary more than 3" from a customer's requirement.

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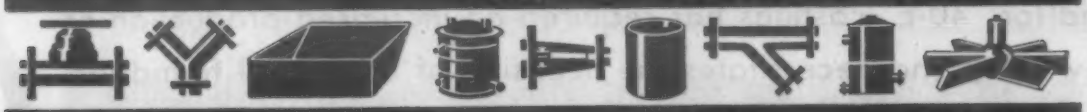

CLEVELAND 550 Leader Building

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a stress of 4,480 p.s.i. for cracked forgings vs. 0.45% for uncracked).

An increase in the sulphur content from 0.013 to 0.044% in a low alloy steel increased the damping capacity slightly, while the addition of 0.29 to 0.54% S to either chromium stainless steel or to 18 Cr-8% Ni caused little change in the damping capacity.

Cold work decreased the damping capacity as shown by the following results on a 0.13% C steel:

Condition	*% Damping Capacity at a Stress of 4,480 p.s.i.*
normalized	1.92
cold drawn 5%	1.48
cold drawn 10%	1.12
cold drawn 25%	0.60

Tests on various heats of Meehanite indicated a damping capacity intermediate between that for cast iron and that for steels. Two stellite samples and a sample of GEC heavy alloy (0.03 C, 88 W, 8 Ni, 3% Cu) were in a class with the sintered carbides and cobalt previously studied.

Average errors are given as: ± 1.95% inherent error (variability in machine); ± 2.98% fixing error (inaccuracy in machining; and ± 2.00% operator error.

—W. H. Hatfield, L. Rotherham & E. M. A. Harvey. *N. E. Coast Instn. Engrs. & Shipbuilders*, Mar. 1944, Advance Copy, 43 pp.

Beryllium Copper in Instruments

Condensed from "Journal of Scientific Instruments"

The use of beryllium-copper for instrument springs and pressure-measuring elements has necessitated some revision of concepts of spring design. It can be formed soft, and the tensile properties developed later by heat treatment; it possesses very much higher tensile and fatigue properties than the old non-ferrous spring materials, and it reduces the inelastic effects found in materials hardened by cold working.

Normally, beryllium-copper has consisted of 2.25 to 2.50% Be, but recently the addition of cobalt has been found to give better and more uniform physical properties. The alloy known as Mallory 73, 2.0 Be, 0.5 Co, 0.1% Si, remainder copper, is the material under discussion.

For flat or cantilever springs, a beryllium-copper spring required to reproduce the characteristics of a steel spring should be 17.5% thicker than the latter. While dimensions would be much the same as for phosphor bronze, the beryllium-copper has a much higher elastic limit and fatigue limit, and considerably greater loads and deflections can be safely employed.

Helical springs in tension or compression are subject to torsional stresses, and elastic limit in torsion and modulus of rigidity are the principal factors involved. Working stresses in beryllium-copper are, say 62,000 to 67,000 p.s.i., as compared to 35,000 to 39,000 p.s.i. for phosphor bronze.

Small ratios of spring diameter to wire

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YOU heat a finished and fully cured Formica sheet by any quick method. While still hot you swing it into a press with wooden or Pregwood forms and form it instantly into shape. When it cools, it holds that shape.

That, in the briefest outline, is all there is to the important new method of forming Formica sheets for the production of shapes which just a little while ago no one thought were possible for that material.

A sheet can be formed to any inside radius no smaller than its thickness. The method is one any production man likes—it works fast, it is accurate; there is a minimum of rejections and waste.

The discovery of this forming procedure adapts the material to many uses for which it was formerly thought to be unadaptable . . . Let us give you all the facts.

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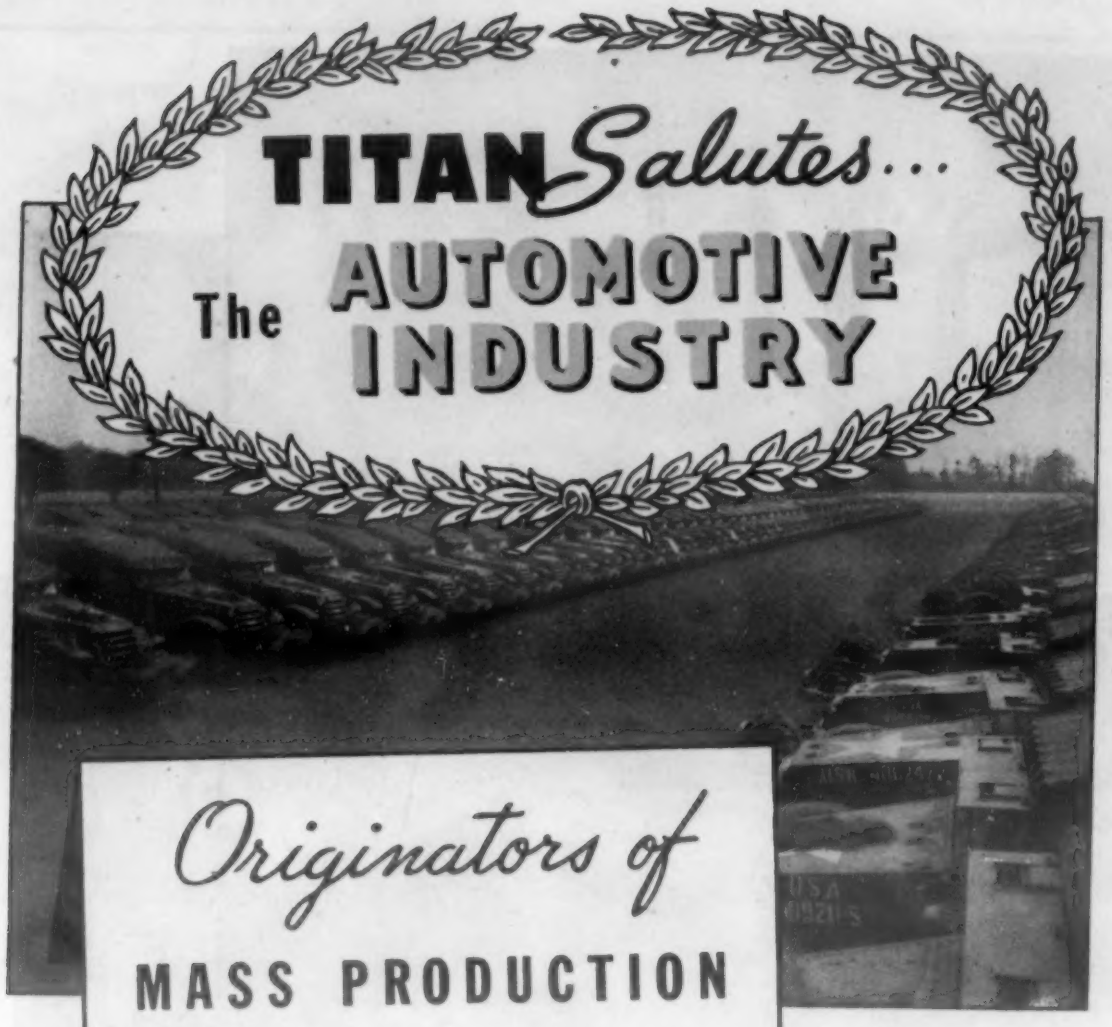

★ TITAN salutes the industry that put the world on wheels. The automotive industry turns out thousands of vehicles a month in peace-time—an industry that now produces an incredible number of planes, tanks, jeeps and trucks with those magic words, "mass production."

War brought a stupendous demand for military machines. The automobile industry converted assembly lines and production systems and used these procedures to manufacture that vitally needed equipment.

Mass production, originated and perfected by this industry, is undoubtedly one of the strongest weapons we possess in our war of supply.

TITAN supplies these assembly lines with hot pressed brass parts of various and intricate shapes, many faultlessly machined for immediate insertion in these machines of war. Call on us after this war is won. We can then supply *you* with superior hot pressed parts.

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diameter should be avoided—approximately 8 is a good working figure. Wire diameter must be 13% greater than for steel to give the same deflection or stiffness.

It would seem from experimental work that beryllium-copper hair springs could be operated with stresses 50% greater than for phosphor bronze. For electrical instruments, the low conductivity of phosphor bronze—about 15% that of standard copper—is a disadvantage, while the cadmium copper or silicon bronze sometimes used to have poor elastic qualities, and are very delicate in handling. Beryllium-copper, with high conductivity, has obvious advantages.

When used in corrugated diaphragms or flexible bellows, beryllium-copper has the advantage of lower hysteresis than phosphor bronze or the nickel alloys. In the fabrication of Bourdon tubes, workability of the material has been a limiting factor, and here beryllium-copper, which can be formed and subsequently heat treated, has an advantage over phosphor bronze, which must be used in the annealed condition.

—L. B. Hunt, *J. Scientific Instruments*, Vol. 21, June 1944, pp. 97-105.

Hardness of Plastics

Condensed from a Paper of the American Society for Testing Materials

Conventional Rockwell hardness tests based on the measurement of the depth of indentation after removal of the major load are not satisfactory for plastics. The proportion of the indentation that is recovered on the removal of the major load is so large that measurements based on this recovered depth are not a true measure of the resistance of the plastics to indentation.

A method of determining the indentation under load was developed by applying a correction for the spring of the frame. This correction is constant and can be compensated for by subtracting it from the dial readings.

With this method of test, the M scale (¼-in. ball, 100 kg. major load) is not suitable for all plastics, since it will indent the softer plastics excessively. The R scale (½-in. ball, 60 kg. major load) is suitable for plastics from the hardest mineral filled thermosetting materials to the softer thermoplastics. Furthermore, with the ½-in. ball, the depth is for practical purposes proportional to the area so the relation of load to area of indentation in the Meyer equation can be determined.

When load is plotted vs. indentation on a log scale, one group of materials (unfilled plastics, wood-flour filled phenolic, XXX paper base laminate, hard rubber) shows a practically linear relation at loads between 30 and 150 kg. with a slope somewhat greater than one. Another group (all compounds containing fillers of various types) shows a perceptible increase of slope between 30 and 60 kg., which then remains fairly constant up to 150 kg.

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We have complete facilities for fabricating brass, bronze, copper or aluminum screw machine parts. We regularly manufacture a wide variety of non-ferrous alloys and are often in a position to compound new or special ones to meet some particular requirement. The properties inherent in copper and its alloys, such as resistance to corrosion, bearing properties, electric or thermal conductivity, machinability, etc., create a great demand for parts fabricated in these materials. Mueller Brass Co. is one of the few large brass mills that manufactures its own rod for fabrication on its own automatic screw machines. All operations are under strict laboratory control and rigid inspection is maintained. Screw machine parts are furnished in any finish required, plain, nickel, chrome, cadmium plated, electro tinned, etc.

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Established 1896
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Two new Rockwell scales are proposed for rapid testing: the alpha using a ½-in. ball, 60 kg. load and 15 sec.; and the beta using a ½-in. ball, 30 kg. load and 15 sec. The hardness number indicating resistance to indentation is obtained by subtracting the scale reading from 150, which has been taken as the limit of penetration.

The alpha scale is suitable for all plastics down to Saran, while the beta scale can be used for materials overlapping in hardness into the alpha range and ranging down to the very soft synthetic shoe sole compositions. Although the load and indentation are not proportional, the hardness readings can be roughly converted to values within 5 scale divisions of observed values by:

$$\text{Alpha} = 2.17B - 175$$

$$\text{Beta} = \frac{175 + \text{Alpha}}{2.17}$$

The degree of reproducibility was checked on 6 machines. Except for one old machine, none showed a deviation from the average of more than about 10%.

Tests on the effect of thickness (1/16 to ½ in.) showed in general an increase in indentation with an increase in thickness, with each material having its own type of curve. Therefore, the hardness value will be to some extent a function of thickness. If several layers of thin sheet are stacked for the test, the hardness reading will also be affected somewhat. In this case, particular care should be taken that the individual layers are absolutely flat.

—L. Boor. *Am. Soc. Testing Materials*, June 1944 meeting. Preprint No. 91, 23 pp.

Corrosion Resistance of Cold-Worked Aluminum

Condensed from "Aluminium"

Of the precipitation-hardenable aluminum alloys, the aluminum-zinc-magnesium alloys have particularly favorable properties in hot-precipitation-hardened state. The strength of an alloy of 4.5 Zn, 2.5 Mg, 0.6% Mn, balance Al, of 42 kg. per sq. mm. (60,000 p.s.i.) could be increased by 2 days hot precipitation-hardening at 100 C. to 48 kg. per sq. mm. (68,000 p.s.i.), or 15%.

The testing of such alloys for stress-corrosion is generally made by taking a sample of the completely hot-precipitation-hardened material and bending it (plastically) and extending it (elastically) in this state. It was found that in this state the sample is considerably more sensitive than if a sample is taken of the cold precipitation-hardened or just quenched material, bent and stretched, and the finished sample is precipitation hardened.

While cold-storing (between the operations) is in the latter case without any influence at all, there is a considerable influence in the former case (with hot-precipitation as last treatment).

The differences are explained by relax-

NEW CASTING SEALANTS
Have high sealing efficiency!
Leave clean surface!
Resistance to gasoline, other solvents!
Easy to handle in plant or foundry!
Excellent stability in operating conditions!

HERE is a group of highly effective new casting sealants developed by Monsanto Plastics research laboratories to replace tung oil which can be applied with the same equipment and virtually the same methods as tung oil itself.

High Sealing Efficiency — Compounded from a viscous, thermosetting base resin and styrene monomer, the new Monsanto sealants have high sealing efficiency because:

1. they have low viscosity to ensure thorough penetration of the finest pores;
2. they contain no solvents to form vapor or air voids;
3. they are polymerized rapidly by a low temperature bake;
4. they form a rubbery, nonporous solid with excellent adhesion to metal when polymerized or cured in the pores.

Good Chemical Resistance — Because the new Monsanto sealants are thermosetting (i.e. once cured, they will not soften again when exposed to heat) they have good thermal stability. When cured, they are insoluble in aromatic high octane gasoline, lubricating oil, ethylene glycol, isopropyl alcohol and water.

Types Available — Two types of the new Monsanto sealants have been developed and thoroughly proved in foundry tests:

X-117 for magnesium castings
X-118 for both magnesium and aluminum.

A third type is now being tested:
X-119 for iron castings.

Leave Clean Surface — All three types can be applied by vacuum pressure impregnation or by positive pressure with few changes in the standard tung oil processing technique.

A clean surface is easy to produce on good castings if they are thoroughly cleaned *after* impregnation but *before* the sealants are cured because the low viscosity of the sealants permits complete drainage and they are soluble in kerosene before they are cured.

Easy to Handle — The new Monsanto sealants are supplied as a mixed impregnating solution or as a base resin to be mixed with styrene monomer. Premixed sealants are simple and easier to handle in the foundry and their uniformity is assured by control laboratory tests before shipment.

For full details and technical help in adapting the new Monsanto casting sealants to your operations, write or wire: MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield 2, Massachusetts.

The broad and versatile Family of Monsanto Plastics includes: Lustron polystyrenes • Cerex heat resistant thermoplastics • Vynate vinyl acetals • Nitron cellulose nitrates • Fibestos cellulose acetates • Resinox phenolics • Resimene melamines. Forms in which they are supplied include: Sheets • Rods • Tubes Molding Compounds • Industrial Resins • Coating Compounds • Vuepak rigid, transparent packaging materials.

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Consider the structure of Z-Metal: hard carbide spheroids in a tough ductile ferritic matrix accompanied by fine particles of graphitic carbon. Starting with this, our metallurgists have developed numerous heat-treating methods by which they can obtain many different combinations of tensile strength, hardness, ductility, impact strength, corrosion resistance and temperature resistance.

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Z METALS

FERROUS METALS CORPORATION
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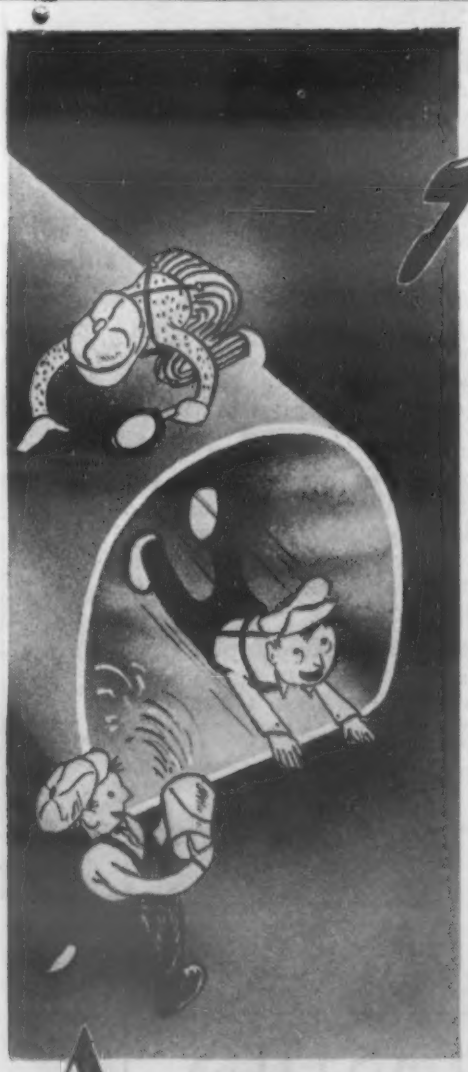
9-FMC-1



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Because Amersil* (fused silica) is 99.8% pure silicon dioxide, it cannot contaminate acids or other chemicals handled in piping, cooling sections, absorbers, etc., made of it and absolute purity of the finished product is assured.

Amersil* is unaffected by any of the mineral acids—except hydroflouric (at all temperatures), and phosphoric above 270°F.—or by the halogens, with the exception of flourine. It withstands, permanently, temperatures up to 2100° F., with peaks up to 2700°F. permissible for short periods. Amersil's ability to withstand sudden and extreme thermal shocks without noticeable expansion or contraction is another of its many valuable characteristics.

For purer finished products, use Amersil* apparatus.

A new Amersil* Catalog is on the press. Write today—on your business letterhead, please—and reserve a copy.

*The registered trade name of the only American manufacturer of a complete line of fused silica products.

AMERSIL COMPANY Inc.

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60 WALL TOWER NEW YORK 5, N. Y.

ation phenomena and elastic stresses due to bending, which are superimposed to residual stresses. It is, therefore, recommended, in order to obtain for practical purposes the highest obtainable resistance against stress-corrosion, to carry out the hot-precipitation hardening only after completed cold-deformation, particularly as shaping operations can be made much better in cold than in the hot-precipitation-hardened condition.

—P. Brenner & W. Feldmann. *Aluminium*, Vol. 25, Nov. 1943, pp. 380-383.

Plastic Railway Car

Condensed from "The Engineers' Digest"

The Southern Railway (British) has recently put into service the first of ten four-wheeled light weight vans for use on passenger trains. High tensile steel wire and cotton mesh in conjunction with plastics or plywood form a material that is used for the bodies of the vehicles. The material is in the form of sheets 6 ft. 6 in. by 3 ft. 3 in., the largest sizes available at present.

The new vehicle weighs 10 tons, 4 cwts., as compared with a similar vehicle of standard design that weighs 13 tons, so that there is a saving of 20% in weight and a small increase in inside capacity. The weight saving is distributed among the underframe, body, wheels, axles and axle-boxes.

The body is separated from the frame by a spring cushioning device by which the body may move longitudinally some inches under the effect of service shocks. The body frame is constructed of light channel sections, 2½ in. by 1¼ in., made from cold-rolled steel strip, electrically welded to the floor framing, which is made of 4-in. by 2-in. rolled channels.

The roof stricks are ash laminations glued together and bolted to the cant rail brackets. The plastic panels are screwed to the body pillars and prevented from working by supporting strips. The floor is of oak and the doors of light steel sheet. The center longitudinals of the floor framing form a cradle to house the springs of the body-cushioning gear.

The underframe is of the cantilever principle, built up by fabrication. In the bearing spring arrangement the weight is passed by volute auxiliary springs to the main laminated springs, between which there is no physical connection other than a double-ended shouldered spigot. Axle-boxes are fabricated from mild steel plate, having open fronts and throw-over lids. The body is spring-cushioned against shock.

The plastic sheets for the body consist of the fabric made up of 24 steel wires and cotton threads to the inch, woven to be self-interlocking. The fabric is impregnated under heat and pressure. The composite material has an ultimate tensile strength of 12 tons per sq. in. in each direction, a specific gravity of 1.7 and an impact value of 16-ft. pounds.

—*The Engineer*, Vol. 177, Mar. 10, 1944, pp. 188-189; as abstracted in *The Engineers' Digest* (American Ed.) Vol. 1, May 1944, pp. 349-350.

Designing Molded Plastics Parts: HEAT RESISTANCE OF PLASTICS

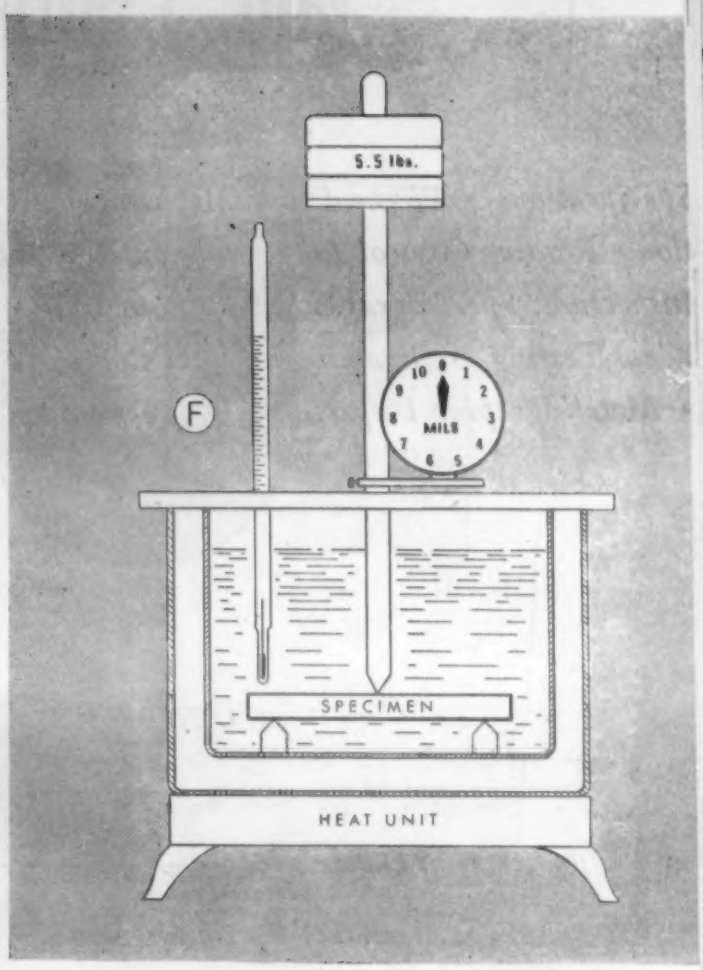
From the engineering files of One Plastics Avenue

The resistance of plastics to heat is a property which is hard to define. In order to work to a definite standard, the ASTM test D648-41T is used to define the **heat distortion point.** It is the temperature at which a 5 x ½ x ½ bar when loaded as a simple beam with a 5.5 lb. weight will deflect 10 mils. Since an actual application will seldom duplicate these conditions, this test is valuable only for comparisons between materials.

The **maximum safe continuous operating temperature** is the highest temperature at which the particular application or part can be used. A part is considered to be above its maximum safe continuous operating temperature if it tends to lose over 10% of its mechanical strength, or loses its surface appearance and becomes blistered, discolored, or distorted.

If a thermosetting material is subjected to continuous heat, it will not soften but will continue to function until it reaches its maximum safe operating temperature. If a thermoplastic material is heated, it tends to soften. The **softening point** is frequently evaluated as that point at which the plastic becomes readily deformed—as for drawing or shaping of thermoplastic sheets. It is usually above the maximum safe operating temperature.

When subjected to high temperatures, most plastic materials will ignite and burn. The **ignition point** is considered to be that temperature at which the material will ignite after 10 seconds exposure. This is the ultimate temperature which the material will stand. A plastic part could, if the exposures to high temperature were short and infrequent enough, operate safely up to the ignition point.



TEST FOR HEAT DISTORTION POINT

Material	Heat Distortion Point 0° F	Maximum Safe Continuous Operating Temperature for Molded Parts (under favorable conditions)	Softening Point	Ignition Temperature
Thermoplastics No load	130-190	140-190	150-260	600-900
Under load		120-170		
Phenolic Woodflour filled	240-250	240-250	None	1000
Asbestos filled	290-300	290-300	None	1150
Urea	260-270	170	None	1300
Mycalex		600	1100	
Cold Molded Non-refractory		500	None	
Refractory		1300	None	

REPRINTS of this advertisement may be obtained by writing Section F-220, One Plastics Avenue, Pittsfield, Mass.

Hear the General Electric radio programs: "The G-E All-girl Orchestra" Sunday 10 P.M. EWT, NBC. "The World Today" news, every weekday 6:45 P.M. EWT, CBS

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Structure and Hardenability

Condensed from a Paper of the "American Society for Metals"

Steels used were NE 9442 and S.A.E. 4620, 4140, 3240, and 4340. The effect of spheroidized, annealed, normalized, hot-rolled, and quenched prior structures on Jominy hardenability over time intervals of 0, 10, and 40 min. and 4 hr. at 1525 F. was investigated. The effect of a range of quenching temperatures from 1450 to 1600 F. was determined on the annealed and normalized prior structures.

The results indicated that in the carburizing S.A.E. 4620, time at 1525 F. up to ten min. shows a discernible hardenability increase only from the two coarser initial structures. Longer times, as well as all periods on the faster cooled structures, have no significant effect; 1450 F. is unsuitable for developing full hardenability while above 1500 F. offers no advantage in obtaining better repsonse to quenching.

Steels in the medium-carbon range reacted essentially alike. The spheroidized and annealed structures were very sensitive to the heating intervals used, yielding values far below normal expectancy at the shorter periods. This range was less for the low-alloyed NE 9442, and was substantially greater for the higher-alloyed types.

The rapidly cooled prior structures showed no important changes in hardenability over the period studied, with the exception of (a) the increase in hardenability at short intervals of S.A.E. 3240 from the normalized and quenched structures, for which no logical reason could be advanced, and (b) the significant decrease of S.A.E. 4340 from all the more rapidly cooled prior structures when exposed for four hr., which was attributed to partial homogenization of a banded structure.

Among the higher-alloyed medium-carbon steels, the normalized structures produced high hardenability at all temperatures. With increasing quenching temperature, the normalized either quickly became constant or attained a maximum value and decreased slightly.

The annealed structure showed a steady increase with quenching temperature. Above 1500 F., both prior states were identical in NE 9442.

Probably more than any other single factor in a given heat of steel, the exact size, shape, and distribution of the carbides determine the success or failure of quenching treatments utilizing short heating cycles.

It appears impossible to predict the hardness traverse of production parts of higher-alloyed medium-carbon steels treated from readily machinable prior structures unless the hardenability test is also conducted under reasonably equivalent conditions of time, temperature, and prior structure.

From the point of view of hardenability, the advantages of long soaking times when conducted on these alloy steels from normalized, hot rolled, or quenched initial conditions appear to have been overestimated. There are some indications of loss of hardenability under these conditions.

—J. Welchner, E. S. Rowland & J. E. Ubben. *Am. Soc. Metals*, Oct. 1943 meeting. Preprint No. 24, 30 pp.

Radiology of Diamond Tools

Condensed from "The Engineers' Digest"

The usual practice in controlling the soundness of the settings of diamonds for industrial use is to dissect several representing a particular batch. Obviously, there is a loss of material and labor as well as no guarantee of perfection in the remaining tools.

By examining every tool by X-rays, however, unsatisfactory settings may now be easily discovered and the diamond subsequently remounted. Also, the size and shape of mounted diamonds may be determined when the question arises of resetting worn, damaged or incorrectly set stones.

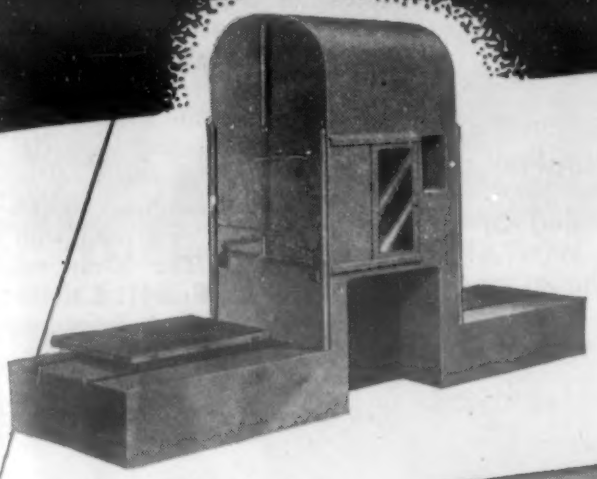
In view of the shape and weight of the metals constituting the usual diamond settings, their X-ray examination normally presents considerable difficulty. A satisfactory technique was finally evolved.

The X-ray tube was fitted with a filter of lead foil 0.003 in. thick. The tools

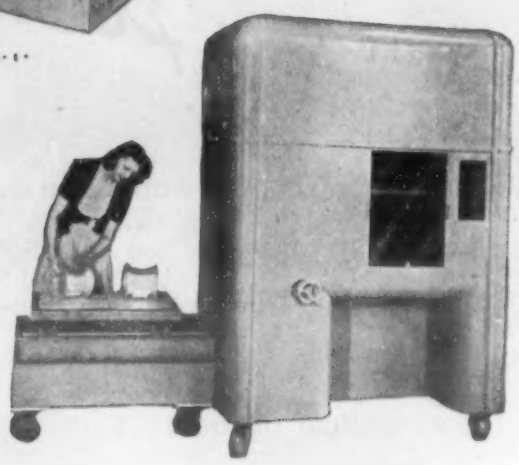
(Continued on page 732)

KELEKET X-RAY CAN IMPROVE YOUR PRODUCT

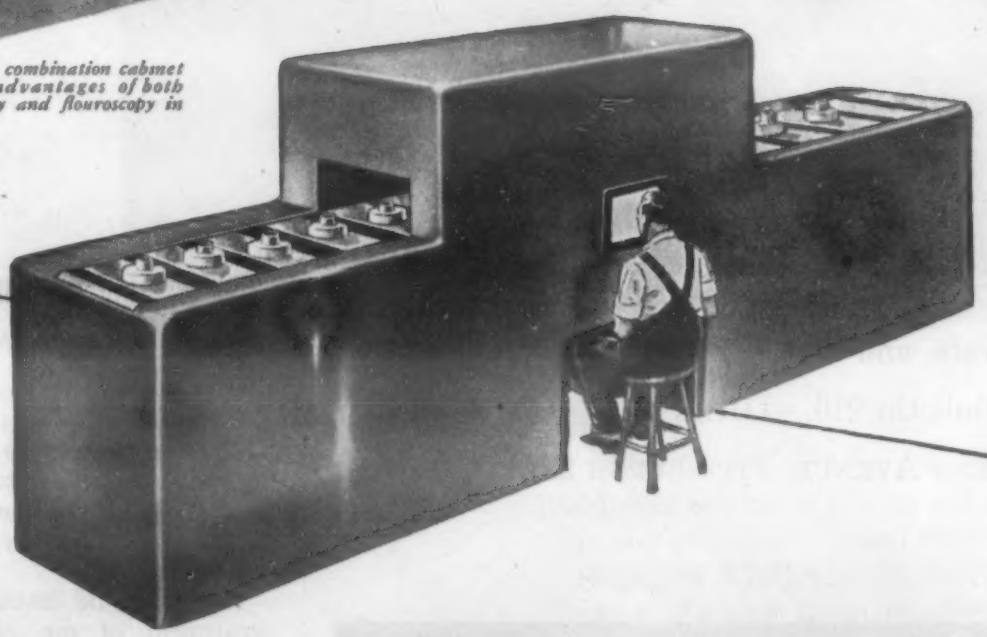
KELEKET *radiographic cabinet used for inspecting critical airplane parts.*



KELFKET *combination cabinet provides advantages of both radiography and flouroscopy in one unit.*



KELEKET's *mobile inspection cabinet operates fluoroscopically or radiographically.*



KELEKET's *conveyor belt fluoroscopic cabinet for high-speed, continuous inspection, may also be used radiographically.*

There is no question about X-ray's performance in industry today—nor the job it can do on the product you make.

Castings? Welds? Complete assemblies? Only X-ray inspection can detect every defect speedily, inexpensively, non-destructively, and before costly machining operations are performed. Marvel of industrial efficiency, no modern plant will do without it.

KELEKET—the quality name in X-ray—knows industrial inspection through and through. KELEKET knows above all that X-ray equipment must fit your plant. That's why KELEKET incorporates X-ray into cabinets—fluoroscopic, radiographic, or a combination of both—if that's what your production set-up requires. That's why KELEKET cabinets are stationary or mobile—or even conveyor units that become an integral part of a moving assembly line.

Hundreds of KELEKET installations in plants all over the country are improving products, cutting costs, and preventing failures in use. Tell us your problem, show us your plant, and we'll demonstrate how X-ray can serve you best.

KELEKET representatives are located in 64 cities in the U.S. and Canada—consult the one nearest you or write direct to Covington for complete information.

ARMY E NAVY

PIONEER CREATORS OF QUALITY X-RAY EQUIPMENT SINCE 1900

KELLEY-KOETT X-RAY MFG. COMPANY

WEST FOURTH ST., COVINGTON, KY.

this girl is identifying STEEL *positively*

With only a few hours training in the operation of the Identometer, this girl can, through the use of known samples of most rolled or forged ferrous alloys, determine if unknown pieces are: (1) of the same or different chemical composition, if the physical structure is the same; (2) of the same heat or different heat treatments, if the chemical composition is the same.

One manufacturer reports 4,000 bars of steel tested and separated into 68 different heats in three weeks time and without delaying production!

The instrument is the Identometer. Its principle: thermo-electricity. It's portable, accurate, and fast. For a full "how it works" description, send now for Bulletin 216. DRAVO CORPORATION, *National Department*, 300 PENN AVENUE, PITTSBURGH 22, PA.

AN ELECTRICAL INSTRUMENT FOR THE INSTANT AND ACCURATE IDENTIFICATION OF MOST ROLLED OR FORGED FERROUS ALLOYS BY THE USE OF REFERENCE SPECIMENS

were immersed in a shallow bath of lead solution just sufficient to cover them. (The lead solution is prepared by separately dissolving equal weights of acetate and lead nitrate in hot water to a fairly high density. The cooled solutions are then mixed and should be rather less dense than a corresponding thickness of specimen metal. The solution density is not critical.)

The bath was then placed upon a lead mask to block all direct radiation from the uncovered film. The film was backed with the usual lead plate. In this way, background fog due to unobstructed primary radiation and scatter radiation was prevented.

Also, the ratio of specimen thickness was reduced by "building-up" the different specimen sections to an approximately uniform level. Several tools may be examined simultaneously. It was found advisable to smear the specimens with vaseline to prevent deposition of lead from the solution.

A tube voltage of about 140,000 with a current of 10 milliamperes and an exposure time of 70 secs. were used with a ⅜-in. thick specimen. The X-ray tube had a small focal spot of only 1.5 sq. mm., which contributed to the high definition obtained.

—E. J. Tunnicliffe. *Ind. Diamond Rev.*, Vol. 4, Feb. 1944, pp. 26-28; as abstracted in *The Engineers' Digest* (Am. Ed.), Vol. 1, Apr. 1944, pp. 292-293.

Polishing Aluminum Specimens

Condensed from "Metal Treatment"

Most aluminum alloys contain relatively hard constituents embedded in a soft matrix, and unsuitable methods of polishing will cause the hard areas to stand out in relief or fill the background with scratches, which may obscure the real structure.

In the method developed in the research department of the Northern Aluminum Co., the specimens are mounted in Bakelite and rubbed down on emery papers flooded with paraffin, using 0, 00, and 000 papers and using a very light finishing pressure. Electrolytic polishing was not successful, and alternate polishing and etching often caused the hard constituents to stand out in relief and appear larger than their true size.

Final polishing is, therefore, carried out by hand on Selvyt cloth, using first a commercial polish which, since the war-time grades have been introduced, is now placed under the polishing pad which acts as a filter to screen out coarse gritty particles. This polish tends to become embedded in the surface and the specimens are therefore polished for about 2 min. with heavy magnesia and for about 3 min. with light magnesia, both being used in the form of suspensions in distilled water.

The photomicrographs reproduced show evidence of the excellent results obtainable by this scheme of polishing.

—H. K. Hardy. *Metal Treatment*, Vol. 11, Spring 1944, pp. 37-44.

HELPING DESIGNERS TO SEE AROUND CORNERS

NEW SF-10R

OVERSIZE ROTATING BEAM FATIGUE MACHINE

BALDWIN SERVES THE NATION . . .
WHICH THE RAILROADS HELPED TO BUILD

Published reports of studies indicate that specimens of 1" minimum diameter eliminates "Size-Effect" in fatigue.

SPECIFICATIONS: Model SF-10 R Rotating Beam Fatigue Testing Machine Capacity: 0-10,000* inch-pounds by units of 5-inch-pounds (Bending Moment). Specimen size: Diameter—1 inch at 100,000 p.s.i. (larger diameters of lower stresses). Length—adjustable from 3½ inches to 9½ inches. Motor drive—1½ H.P., 220 volt, 3 phase, 60 cycle, 3600** RPM. Length—6'-3". Width—1'-10". Height—4'-0". Net weight—1500 pounds. *Shipping* weight—1900 pounds. *1000 inch-pounds on beam. Additional capacities by four 2000 and one 1000 inch-pounds weights hung on beam end. **Slower speed or multiple speed motors as ordered.

The Baldwin Locomotive Works, Baldwin Southwark Division, Philadelphia, Penna., U.S.A. Offices: Philadelphia, New York, Chicago, Washington, Boston, Cleveland, St. Louis, San Francisco, Houston.

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Hydraulic presses, Testing equipment, Steel forgings and castings, Diesel-electric locomotives, Diesel engines, Metal plate fabrication, Rolled steel rings, Bronze castings, Heavy machine work, Crane wheels, Bending rolls, Plate planers, Babbitt metal, Alloy iron castings, Briquetting presses.

BLW THE BALDWIN GROUP **BALDWIN**

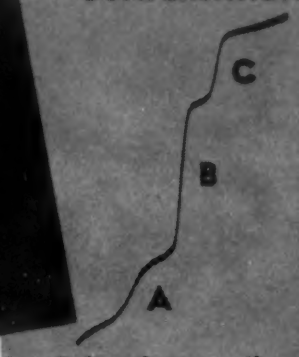
SOUTHWARK
TESTING EQUIPMENT

THE NEW MODEL XII

Heyrovsky Polarograph

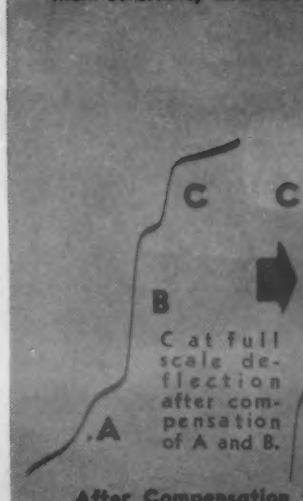
incorporates counter current compensation and improved camera.

USE OF COUNTER CURRENT COMPENSATION



Before Compensating for Constituents A and B

Constituent C is the element to be determined, but under the conditions illustrated, the concentrations of constituents A and B are so large that C cannot be measured at maximum sensitivity and accuracy.



After Compensation for Constituents A and B

This clearly illustrates the important advantages of current compensation . . . constituent C can now be measured with maximum accuracy and without the necessity for time-consuming chemical removal of constituents A and B.

● Accuracy; rapidity; the possibility of detecting and identifying minute quantities and of making simultaneous determinations of several components; small sample requirement; preservation of sample and permanent photographic recording of every analysis, are some of the reasons why the Heyrovsky Polarograph is so widely used.

The procedures established thus far by no means define the field of polarography — the perfected instrumental system of the Heyrovsky Polarograph creates unlimited possibilities for analytical and research applications.

A bibliography of more than 700 papers dealing with the polarographic method of analysis and a booklet discussing the Polarograph and polarographic analysis are available without charge on request.

The application of polarographic methods of analysis expands steadily. Some of the applications of the Heyrovsky Polarographs now in use are—Analysis of waters for trace constituents • Observation of deterioration of transformer oils • Detection of incipient lead poisoning • Organic research. Analysis of: Brass • Ferrous alloys • Lead alloys • Magnesium alloys • Nickel alloys • Zinc alloys • Metallic impurities in aluminum • Lead and zinc in paints • Major constituents in plating solutions • Ceramics and glasses • Raw materials for production of rubber • Vulcanized rubber for identification of specific ingredients • Foods • Paper ash and pulping liquors.

S-29301 POLAROGRAPH—Heyrovsky, American Model XII, Indicating-Recording, With Current Compensator. Complete with accessories. For operation from 115 volts, A.C. 60 cycle circuits **$550.00**

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Michigan Division: 1959 East Jefferson, Detroit 7, Michigan

SARGENT
SCIENTIFIC LABORATORY SUPPLIES

Bending Test Relationships

Condensed from
"Zeitschrift Ver. deut. Ing."

The adaptability of structural steels for welded construction is usually tested by the notch-impact test or the "weld-on" bending test. For the practice it was important to know whether the results of these two tests agree with each other and can serve as a basis for judging the behavior of the steels in actual service.

A survey of literature and new experiments was made in the temperature range from +60 C. to —60 C. with the structural steels St 42 and St 52. Carefully made tests established with certainty that no relation could be found between the shape of the fracture in the weld-on bending specimen and the notch-impact toughness, both in the condition "as delivered" and in aged condition at different testing temperatures or after cold-deformation of different degrees.

A special advantage of the notch-impact test, in spite of some disadvantages in its application, is seen in the fact that it permits distinguishing between deformation fracture and separation fracture.

The investigations with weld-on specimens showed that here, as in the notch-impact test, both forms of fracture take place and that the transition from the one to the other form occurs in a temperature range between —40 C. and 0 C.

The direct applicability of such results to measurements on structures is, however, too uncertain, as conditions such as section, notch effects, cracks, etc., play too big a role; the natural form of fracture seems to be the separation fracture.

—K. Albers. *Z. Ver. deut. Ing.*, Vol. 87, Oct. 30, 1943, pp. 677-682.

Toolmaker Microscope in Inspection

Condensed from
"Screw Machine Engineering"

The toolmaker microscope, in conjunction with recently improved thread charts, is adaptable as a comparator. In any optical comparator the gaging accuracy is fundamentally determined by the excellence of both the image and the reference chart.

Generally speaking, the toolmaker microscope will produce an image of greater sharpness or definition due to: (1) A very short path of beam insuring maximum of contrast; (2) forming of the image on a clear glass reticule undisturbed by coarseness of "grain"; and (3) additional magnification of the image by the power of the eyepiece.

The projector type of chart is necessarily produced with a ground or frosted glass surface, the "grain" of which adversely affects the definition of the image. Also, the accuracy of this chart is only equal to the precision with which the drawing can be made.

How would you lubricate bearings in a vacuum?

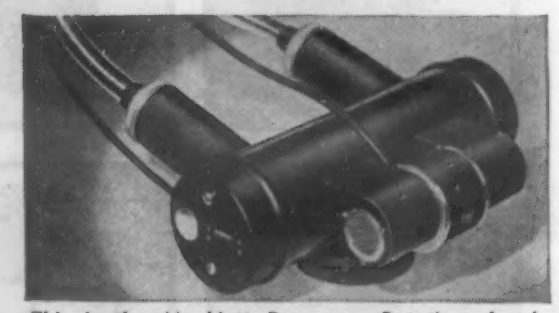
ANOTHER MACHLETT TECHNIQUE

This is a cross-section of the Machlett Dynamax X-ray tube. The ball bearings support the anode, which rotates at 3000 r.p.m., and reaches a temperature of 1000° F. The entire structure is in a vacuum of about 10^{-6} mm. of mercury, or a billionth of an atmosphere.

Conventional lubricants cannot be used, because they would destroy the vacuum and the tube. Machlett's scientific studies showed that a very thin film of certain metals can act as lubricant. Pure silver was found most advantageous. An almost molecular-thin film of it is deposited upon the balls in a vacuum, by a unique method.

So successful was this technique that Machlett, five years ago, guaranteed its Dynamax rotating anode tube for 10,000 exposures. Today it outlasts conventional stationary anode tubes. Some amazing records have been made with it, the best to date being 272,610 exposures, at the Army Examining and Induction Station, Pittsburgh, Pa.

This tube has a focal spot so small as to produce exceedingly sharp pictures, and an X-ray beam so intense as to make possible exposures as short as 1/60th sec. It was the solution of the lubrication problem that added reliability to these advantages. Machlett employs many other advanced techniques in the manufacture of its various types of high-vacuum tubes for medical, scientific and industrial purposes . . . Machlett Laboratories, Inc., Springdale, Connecticut.



This is the Machlett Dynamax Rotating Anode tube, 100 kilovolts, 50 kilowatts, as supplied in an oil-filled, shockproof housing with air circulator and vapor-proof cable terminals.

MACHLETT

X RAY TUBES SINCE 1898

TODAY THEIR LARGEST MAKER

"Speed YOUR Analyses"

. . . through weighing with LIGHT!"

COLEMAN UNIVERSAL SPECTROPHOTOMETER

Eliminate tedious CHEMICAL separations . . . chrome and manganese are done at the same time! We send exact procedure with each instrument! Our Model II Coleman Spectrophotometer replaces all filter photoelectric colorimeters as ANY band is available with turn of ONE knob! Simple round or square test tubes for samples!

Ask Youngstown Sheet, Wisconsin Steel, Keokuk Electro-Metals, Sivyer Steel, Carnegie-Illinois, Goodman, etc.

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"ROCKWELL" *Motorized* HARDNESS TESTER

"ROCKWELL" *Internal* HARDNESS TESTER

"ROCKWELL" *Superficial* HARDNESS TESTER

"ROCKWELL" HARDNESS TESTER

The "ROCKWELL" Hardness Tester, originally developed for research and tool-room use, has, in its modern convenient and speedy form, become the most important instrument for quantity inspection hardness testing in many thousands of metal working plants.

WILSON

MECHANICAL INSTRUMENT CO. INC.

AN ASSOCIATE COMPANY OF AMERICAN CHAIN & CABLE COMPANY, INC.

The toolmaker microscope demands an entirely different method for the preparation of charts. The scale of the chart has to correspond to the initial magnification in the instrument, normally 3 X. The master drawing is made to a scale of 50 to 1 or even higher, making errors relatively insignificant.

From this the chart is reproduced by a photographic reduction and etching process, which practically wipes out any residual error in the original layout. Due to this small scale, it is possible to combine a whole series of patterns within a plate of less than 10 sq. in.

A circular type of rotating chart would be mounted in an eccentric adapter. As it is practically an integral part of the ocular, any change from one chart to another involves the complete ocular head.

This expensive handicap has been removed by the introduction of a rectangular type of chart. In this design only one ocular head proper is required for the instrument while the charts are separate units. This removes limitations previously caused by fixed circular charts, and as a result the flexibility of the tollmaker microscope will approach that of the contour projector.

—F. Koenig. *Screw Machine Engrg.*, Vol. 5, June 1944, pp. 40, 42-48.

Hardness vs. Conductivity Testing

Condensed from
"Zeitschrift für Metallkunde"

Among the methods of destructionless testing of materials, the measurement of the electric conductivity is a good indication of the behavior of a material; thermal treatment, and especially hardness, can conveniently be determined in this manner.

Tests were made with three aluminum alloys (1 Mg, 1 Si, 0.87 Mn, 0.52 Fe, 0.02% Cu), (4.2 Cu, 0.70 Mg, 0.55 Mn, 0.30 Si, 0.45% Fe), and (4.5 Zn, 3.5 Mg, 0.3% Mn) in which the change of the electric resistance and of the hardness were determined as function of the quenching temperature and of the precipitation-hardening during storing at room temperature. All specimens showed that the hardness of the cold-precipitation-hardened alloys is within wide limits proportional to their resistance.

Hardness and resistance increase with increasing quenching temperature, in accordance with the greater formation of solid solutions, and the amount of change by cold-precipitation hardening also increases with increasing quenching temperature.

Hardness increases, both directly after quenching and after completed precipitation hardening, linearly with the resistance, so that it is possible to determine the hardness from a measurement of electric conductivity, without any complicated apparatus and without much loss of time.

—W. Koster & H. Breitfeld. *Z. Metallkunde*, Aug. 1943, pp. 163-166.

Q. *WHICH X-RAY FILM*

for a welded seam in ½-inch steel with 200 kilovolts?

A. *KODAK'S TYPE "M"*

with lead-foil screens

IN critical inspection of welds in relatively thin steel, Kodak Industrial X-ray Film, Type "M," used with lead-foil screens, is first choice.

Type "M," because of its exceptionally fine grain and high contrast, will give you the extra detail needed to determine more positively whether the weld is sound—has satisfactory penetration, is well-fused, and is free from objectionable or harmful slag, inclusions, cracks, or porosity.

Its speed permits reasonably short exposures through steel ½ inch thick at 200 kilovolts.

Film Choice Depends Upon Your Own Requirements

Your own operations may not call for the examination of welds . . . may require some entirely different type of industrial x-ray film. Your selection of film should be governed by . . .

. . . whether your radiographic equipment can deliver a range of high kilovoltages that permit short exposures through thicker sections or whether available voltages are relatively low.

. . . whether a critical inspection of some especially important area is called for or whether a routine, over-all examination will suffice . . .

. . . whether long exposures can be made without hampering shop operations or whether exposures must be as short as possible . . .

There's a Kodak Industrial X-ray Film Specially Made to Handle Your Job

In addition to Type "M" . . .

Kodak Industrial X-ray Film, Type "K" . . . is primarily intended for gamma radiography, with lead-foil screens, of heavy steel parts or of lighter parts at low x-ray voltages.

Kodak Industrial X-ray Film, Type "F" . . . used with calcium tungstate screens, is intended chiefly for the radiography of heavy steel parts.

Kodak Industrial X-ray Film, Type "A" . . . is designed for use with light alloys at lower voltages and for million-volt radiography of thick steel parts.

EASTMAN KODAK COMPANY

X-ray Division

Rochester 4, N. Y.

Kodak

The Film tells the story

books

FOR METALLURGICAL ENGINEERS

Tool Steels

TOOL STEELS. *By J. P. Gill, R. S. Rose, G. A. Roberts, H. G. Johnstin & R. B. George. Published by American Society for Metals, Cleveland, Ohio, 1944. Cloth, 6 x 9 in., 577 pages. Price $6.00.*

This book represents the latest compilation of data on the vitally important subject of tool steels. It comes from a source which has, for a period of years, been publishing information on tool steels in the form of technical papers and educational lectures given at A.S.M. conventions. In this present work, the authors have brought together the material from these previous lectures and investigations and combined it with the other available data in the field, to produce a complete and well rounded book.

While the book gives a resumé of the historical background of the art and outlines the essentials of tool steelmaking practice, it, as the authors state in the preface, is primarily intended for the user of tools and tool steels, and this material is included more to round out the picture than to completely cover this phase of the subject.

An innovation is a classification table of tool steels where various types have been grouped by a sort of mixed system of classification according to some predominant property. The steels in each group have been given a significant identifying number, which number is carried throughout the book, making a very convenient method of reference. The idea is good and particularly advantageous if the book should find use as a text, although the classification table seems to us a bit lengthy and capable of some advantageous condensing.

The last half of the book is given over to a comprehensive discussion of the properties and uses of the various tool steels, following the group classifications previously laid out. This section of the book, which is profusely illustrated with numerous charts and tabulations of useful facts, will, we feel, be the one of primary interest and value to most readers.

While the book does not produce any new theories or facts on the subject, it does bring together in one volume the results of the authors' experience, plus the meat of practically all that has been published on the subject to date. Not the least item of value is the very complete bibliography of over 500 references.

—S. C. SPALDING.

The Basic Open Hearth

BASIC OPEN HEARTH STEELMAKING. *By the Committee on Physical Chemistry of Steelmaking. Published by American Institute of Mining & Metallurgical Engineers, New York, 1944. Cloth, 6½ x 9¼ in., 632 pages. Price $3.00; members of the Society, $2.00.*

This is, to the nth degree, a cooperative effort. Two dozen authors collaborated directly and 3 dozen competent critics had fingers in the pie. It has a double purpose: To give the present operating man better insight into the whys and wherefores of technique favoring high production and high quality; and to give the metallurgical student (the future operator) some understanding of the equipment and processes through which the physical chemistry of steelmaking is applied. Both purposes are well accomplished; the book is readable by either group.

Starting with the furnaces and a preliminary survey of what goes on in them, the theme unfolds through chapters on refractories, raw materials, slag control methods, charging and melting practice, refining, finishing, pouring, ingot structure and segregation, non-metallic inclusions; and ends with a discussion of the effects of steelmaking practice on the properties of steel.

Part II, dealing with theory, starts with a general discussion of the physical chemistry that is to be applied, and then takes up combustion, the thermal changes in melting and refining, what goes on in liquid steel slags, gas flow and heat transfer, and reaction rates.

That getting what you want out of an open-hearth is, in some details, a science, amenable to control by quantitative measurement, but in some others, an art, controlled only through personal experience, is clearly brought out. Regulation of various steps in practice according to ingot size is more clearly discussed than in other printed sources. The topic of segregation as a function of ingot size and weight is very clearly treated.

It is good to have an official statement, pages 311 to 312, as to how a practice may build up, *i.e.*, trouble comes, some special precaution, say an expensive addition agent is used, simultaneously tightening up all along the line, the trouble ceases, the addition is thereafter specified, but sometimes the shop runs out of it and heats without it are OK. It was something else in the tightening-up process that did the trick.

Hardenability variations and the fact that, under present control, hardenability does vary, from heat to heat and ingot to ingot, are squarely faced.

Especially in the section on effect of practice on properties, there are many sane and quotable comments. One in an earlier section, discussing causes of off-heats, gives as cause No. 11—"Damned carelessness."

The theoretical section of the book, the chemistry and physics of what goes on, has been boiled down in masterly fashion. If the first part of the book is read first, as it will be by the practical man, and should be by the chemist whose courses in physical chemistry have dealt chiefly with aqueous solutions, the practical man will see the need for the shorthand of the physical chemistry equations and the student will see that there is a real application for theory.

The book is tops in all respects. Fitting the content, treatment, emphasis and order of presentation in a technical book to the readers who need the information has seldom been so nicely done.

—H. W. GILLETT

Other New Books

WORK METHODS MANUAL. *By Ralph M. Barnes. Published by John Wiley & Sons, Inc., New York, 1944. Cloth, 5¾ x 3¾ in., 136 pages. Price $1.75.* This book is offered as a guide for supervisors, foremen and workers. It discusses the principles of motion economy and work organization. The author's aim is to demonstrate how to do the job with greater economy and efficiency, as well as with less effort.

THE WELDING ENCYCLOPEDIA, 11TH EDITION. *Re-edited by T. B. Jefferson. Published by The Welding Engineer Publishing Co., Chicago, 1943. Simulated leather, 6 x 9 in., 976 pages. Price $6.00.* The eleventh edition of this work has been completely rewritten to take into account the many advances made in welding during the past few years. Subject matter has been arranged alphabetically to assist the reader in locating any topic easily, and ample cross-references have been provided. The chapters on metallurgy in particular have been expanded, so that the book will answer many "whys" as well as "hows".

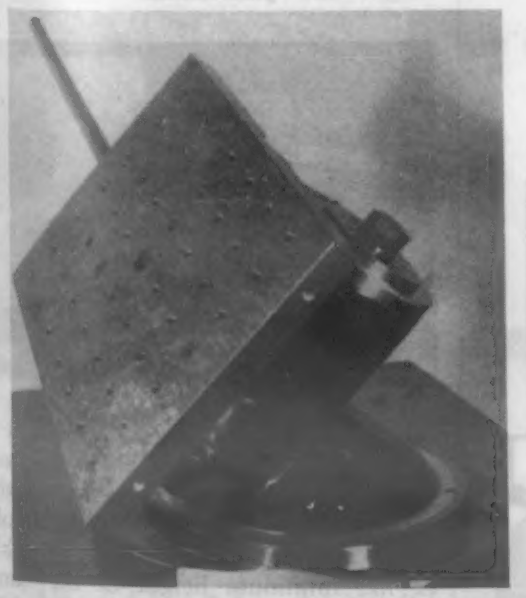
METALLURGICAL ENGINEERING news

Equipment • Finishes • Materials • Methods • Processes • Products
Alloys • Applications • Designs • People • Plants • Societies

Universal Compound Angle Plate

A new model universal compound angle plate that can hold work in any position from 0 to 90° in two planes that are 90° apart and in any position within 360° of the radial axis, is announced by the *Angle Computer Co.*, 5720 Melrose Ave., Los Angeles 38. A surface plate, from a parallel position to the base, may be tilted 90° in two directions also, rotated in the base 360°.

Users can save about 50% of the time



formerly consumed in the set up of work. Calibration is done by protractors and verniers, two protractors being of 5 in. diam., a third 10 in. diam., all graduated in half degrees. The vernier is graduated to one minute, accurate within 10 sec. of the arc.

The surface plate will move in three planes, each having its own locking unit, so that the surface plate can be moved in any one of the three planes, the other two locked in place. The radial plane or cylindrical rotation in the base is tightened by a tubular nut beneath the surface plate with the use of a ¾ in. actuating bar.

Locking of both tilt angles of the surface plate is done by a wrench on two standard ¾ in. nuts, 90° apart on the outside of the journal of the 90° trunnion in the center of where the 5 in. protractors are mounted.

When both, or either, of these two lock nuts are loosened, the surface plate will remain at the angle it is set. This is accomplished by a spring loaded head attached to each journal. Actuation of the surface plate is accomplished by the use of the ¾ in. actuating bar inserted into the holes bored into the ribs on the under side of the surface plate.

Tap Reconditioner

An improved design of tap reconditioner for applications in chamfering, flute grinding, spiral pointing and point polishing has been brought out by *Detroit Tap and Tool Co.*, 8432 Butler St., Detroit 11. Known as Model DTR-3, it has been transformed into a "4-in-1" machine by addition of facilities for grinding the full length of the tap flutes to the machine's original three functions.

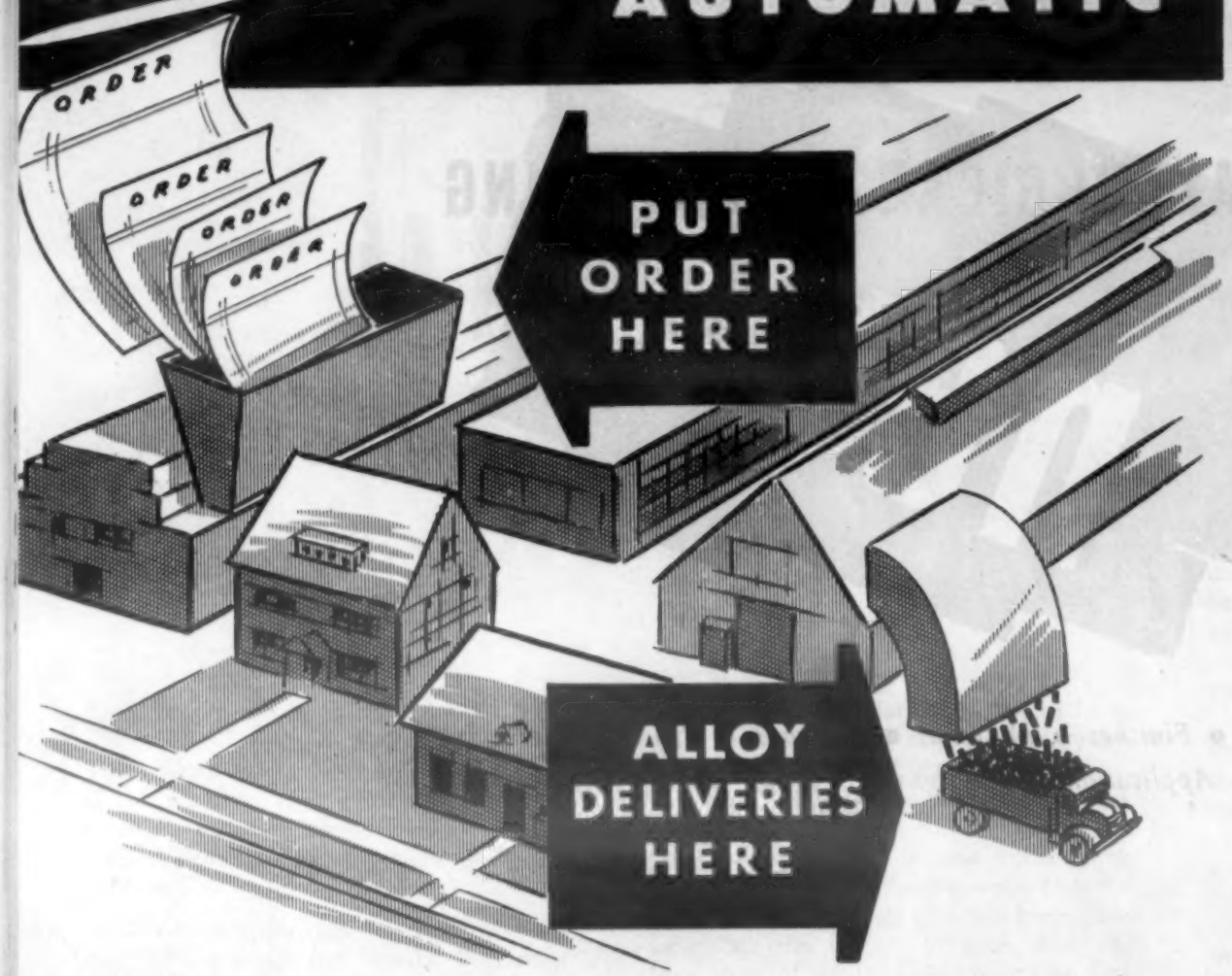
Taps with 2, 3, 4, 5 or 6 flutes may be ground on one head. The entire flute grinding and spiral pointing unit is now of the sliding table type for increased accuracy and easier grinding. A new chamfering head employs "quick change" type collet chucks for standard tap shank sizes. The chucks are interchangeable between the chamfering unit of the reconditioner and the unit for flute grinding and spiral pointing and are attached by a simple draw bar, eliminating lock nuts on both heads.

Units will now accommodate collets from the smallest machine screw size up to 1¼ in. standard tap shank size, including long shank tapper taps. The spindle head now accommodates interchangeably a wide range of motor types for the various service voltages, phases and frequencies required.

The spindle assembly is mounted on large dove tail ways in the pedestal base, promoting high rigidity of spindle head and continuous adjustability for grinding tool wear. Full protection against grinding dust is provided. In polishing the spiral points, sticking of chips is eliminated.

The ½ h.p. spindle motor is controlled by a manual switch in the machine's base. Standard motors are 220- or 440-v., 3 phase, and 110-v., single phase, for either 25 or 60 cycle service. Among standard accessories are a tap locator and 3 index discs for flute grinding and spiral pointing, accommodating from 2 to 6 flutes.

Service IS ALMOST AUTOMATIC



Maybe the cartoon does exaggerate a little but it does get over a fact that hundreds of customers already know—"Falls" Service is Fast.

We pride ourselves that our service is timed to today's requirements, that alloys, needed in a hurry, are ready for you in a hurry. One indication of our service is the fact that more than 300 different types of alloy are carried in stock for immediate shipment.

As America's largest producer of quality alloys, with a production capacity of over 70 million pounds per year, you'll find Niagara Falls Smelting and Refining Corporation the quick, dependable source for any alloys you need. And our laboratory control insures the quality of every shipment.

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The wealth of alloy knowledge that we have in our files is always at your disposal. We welcome the opportunity to offer it to you in hopes that it may prove valuable in solving your present or peace time alloy problems. Write us today —or better still—call us.

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NIAGARA FALLS SMELTING & REFINING CORPORATION

America's Largest Producers of Alloys

BUFFALO 17, NEW YORK

Optical Flats and Monochromatic Light

Greater wearability and lower coefficient of expansion feature the new DoAll optical flats, made by *Continental Machines, Inc.*, 1301 Washington Ave., S., Minneapolis 4. Made from fused Brazilian quartz, having a hardness of 7 on the Moh scale, compared with 6 for optical grade glass and with

a much lower coefficient of expansion than pyrex or optical grade glass, DoAll remains flat after considerable handling.

These features speed the accurate inspection of master flats, flat surfaces of gages, machine parts, anvils of micrometers, comparators and steel bars. Six sizes in diameters from 2 to 10 in. are available. They carry marked accuracy guarantees showing variance in absolute flatness. Accuracies are: One-millionth inch for laboratory gage block and instrument inspection and two-millionths for checking instruments and fine tools.

DoAll optical flats using light waves from a monochromatic light provide industry with the greatest accuracy for making fine measurements.

Continental also offers a monochromatic light having large adjustable capacity and compactness, called the DoAll Monolight using helium light rays, the gas being in highly purified form, one wave length only and with a distinguishable color, yellow.

The light is high in intensity, hence concentrating on a smaller area, giving greater illumination for distinguishing the light wave unit known as the "fringe," or interference band. The rays through the optical flats produce interference bands of 11.6 micro inches, used to measure flatness, height and parallelism.

One can read accurately, within millionths of an inch, variations in the size and flatness of parts when viewed through the combination of optical flat and monolight.

The maximum height, lamp to table, is 12 in.; minimum height of the lamp to table, 8½ in.; projection head tilts, 90° up and 21° down; rotates 360°; the projection head is removable for inspection in hand; the net weight is 12 lb.; the operating current is 110 v. 60 cycle, single phase.

An Important

ANNOUNCEMENT

to Electrode and Anode users

SO THAT OUR product development men will be better able to keep pace with developments in your industry, National Carbon Company, Inc., has just reorganized and expanded its Electrode Service Engineering Department.

This department concerns itself constantly with the improvement of carbon and graphite electrodes and graphite anodes. It also consults with and advises customers in the electrometallurgical and electrochemical industries on the application technique, and the efficient use of electrodes and anodes.

The key personnel of the reorganized department is headed by T. L. Nelson, and will consist of Dr. Charles H. Chappell, in charge of the electrothermic service division, and Dr. Neal J. Johnson, in charge of the electrolytic service division.

Mr. Nelson brings to the work both academic and practical training. For fifteen years he guided quality control operations for many of the carbon and graphite products of the company. He has spent much time in the field on actual application problems involving the use of electric-furnace electrodes.

Dr. Chappell's education and training also make him exceptionally qualified as supervisor of electrothermic work of the new department, while Dr. Johnson, outstanding research and process-engineering scientist, is thoroughly familiar with problems arising in the electrolytic division.

Many trained technical assistants are on the staff of the department, the entire facilities of which will immediately be placed at your service upon notice to any member of our nation-wide sales department.

BUY UNITED STATES WAR BONDS

The "National" and "Acheson" Seals, as well as the words "National" and "Acheson" are registered trade-marks of National Carbon Company, Inc.

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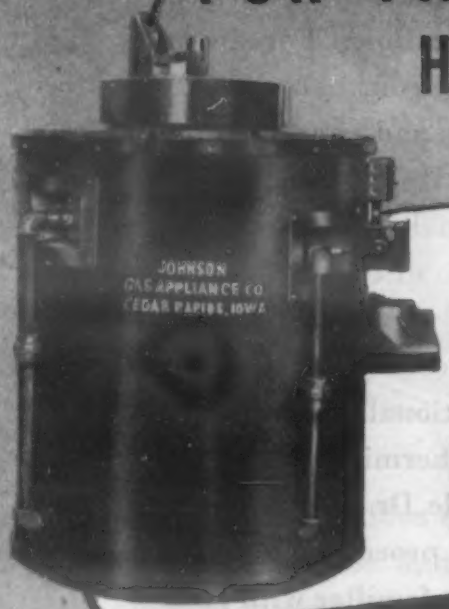
Johnson Furnaces

FOR FAST LOW COST HEAT TREATING

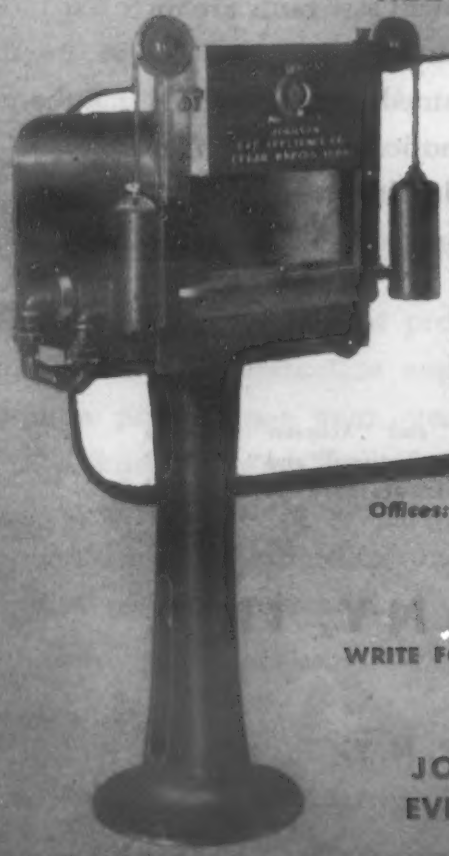


No. 575

Pot Hardening Furnace

Lid-lifting mechanism of this Johnson Unit easily lifts lid and locks it in UP position. Heavily lined with 8" hi-temperature, hi-quality insulation. Features conveniently located dump door, automatic lighting device, vent damper to regulate exhaust gas flow. 14 x 20 pot. 3-Section top ring construction prevents distortion. Complete with G. E. Motor and Large blower. $400 F.O.B.

ALL PRICES F.O.B. FACTORY



No. 130-A

Hi-Speed Steel Heat-Treating Furnace

Counterbalanced door opens upwards so tools may be inserted or withdrawn without fully opening door. Carbofrax Hearth in heavily insulated 7¾ x 13 x 16½ Firebox. Complete with G. E. Motor and Johnson Blower, 4-Burner Unit for temperatures 1400° to 2000° F. $295 F.O.B. 6-Burner Unit for temperatures 1800° to 2400° F. $325 F.O.B.

Offices: 120 Liberty Street, New York 6, N.Y.
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JOHNSON GAS APPLIANCE CO.
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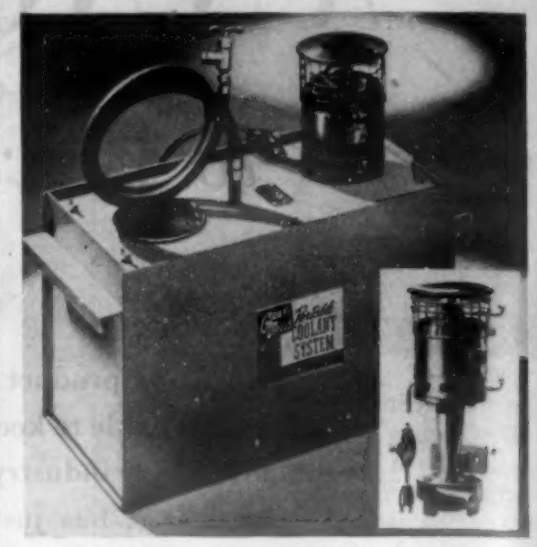
Coolant System and Pump

A new coolant system for grinders, cut-off saws, milling machines and such operations as fine abrasive cutting and honing is announced by the *Gray-Mills Co.*, 1948 Ridge Ave., Evanston, Ill. Called Model 1130, the unit is simple, compact, sturdy and easily portable. It fits snugly under a machine or in any out-of-the way place.



Forced-settling baffle plates are built into the tank to reduce circulation of solids.

Heart of the system is the centrifugal pump with a capacity of 1200 g.p.h. (water) at 0 head, 360 g.p.h. at 5 ft. head. The motor is 1/15 h.p., with sealed bearings. The pump is also designed for in-built coolant systems and for pumps, etc.

The mounting bracket permits vertical or horizontal attachment, or it may rest on its 3-legged base. Abrasives or chips pass through the pump without binding or abrading. The motor cannot be overloaded when the discharge is cut down or stopped.

Oil Circulating and Heating Unit

An oil heating unit to provide heat transfer oil to machines that require elevated temperatures is announced by *Youngstown Miller Co.*, Sandusky, Ohio. Called Model S-12, it has 12.8 kw. of electric heaters applied externally to the heating portion of the tanks, with capacity for 12 gal. of oil.

A simple selector switch enables changing the controlled temperature from one to another by putting either of the three thermostats into the electric current.

The heated oil is circulated by a rotary pump driven by a ½ h.p., 1150 r.p.m. direct connected motor. The pump is so located that any drip from the stuffing box returns to the main circulating oil pool. A selector switch provides no heat, partial heat, or full heat. Lighted jewels signal the prevailing setting.

A float inside of the heating tank indicates visibly the level of oil, a thermometer showing the temperature. Contact of the oil with air is minimized to reduce tendency for oxidation. Any three temperatures between 200 and 500°, included, can be pre-selected.

AMCO EQUIPMENT

for steel mills . . .

AMCO INGOT HEATING PIT FURNACES
Prospective purchasers should find out *why* 165 AMCO *Soaking Pits have been purchased* in recent years.

AMCO SIDE DOOR HEATING FURNACES
For reheating plate and forging ingots, slabs, and billets of all sizes—continuous doors where desirable.

AMCO CONTINUOUS PUSHER TYPE FURNACES
For reheating slabs and billets. Ingots *up to 17" thickness* successfully heated in charging-end-fired furnaces.

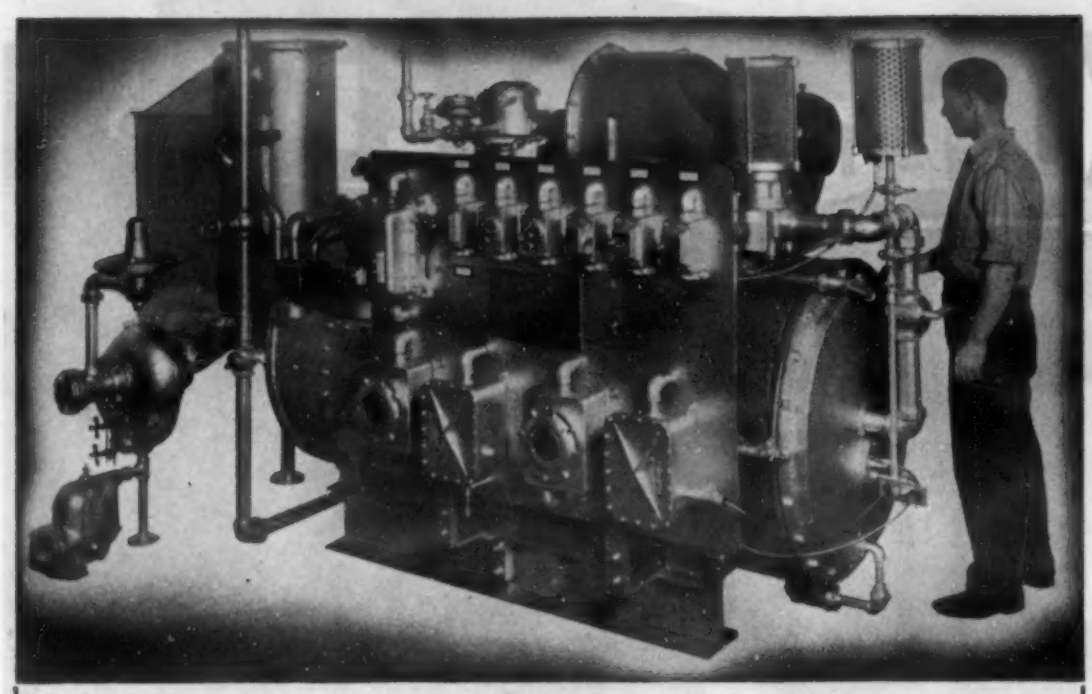
AMCO ALL REFRACTORY RECUPERATORS
More than 600 AMCO Recuperators installed in the steel industry during the past 8 years; preheated air temperatures up to within 700° F. of waste products temperatures.

AMCO OPEN HEARTH FURNACES
All sizes and types, complete with full automatic control and reversing.

AMCO PULVERIZED COAL SYSTEMS
Including long distance transport—for all types of industrial reheating furnaces.

AMCO ENGINEERING AND CONSTRUCTION SERVICE
Inquiries solicited for redesigning, rebuilding, relocating furnaces; dismantling, moving, erecting other heavy equipment.

The AMSLER-MORTON Company
FULTON BUILDING · PITTSBURGH, PA.



For Purging—

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Specify the Kemp Inert Gas Producer where processing conditions or requirements call for inert or protective atmospheres.

Kemp Inert Gas Generators are available in capacities ranging from 1000 to 100,000 cubic feet per hour, may be furnished for semi-automatic or automatic operation. Safety features include electric ignition, safety pilot, soft heads, fire checks, and automatic shutdown in the event of

(a) burner outage

(b) cooling water failure, or

(c) fuel gas supply failure.

The inert atmosphere is delivered at a temperature of not more than 15° F. above the inlet temperature of cooling water with a corresponding dewpoint. When dryer gases are required, low dewpoints may be obtained by selection of suitable auxiliary drying equipment.

Write for engineering data, recommendations, and quotations.

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Submerged Combustion Burners
A complete line of Industrial Burners, and Fire Checks

KEMP of BALTIMORE

General Purpose Hydraulic Presses

Complete redesign and restyling in general purpose "Junior" hydraulic presses, bench and base types, are announced by *Colonial Broach Co.*, Detroit. The line comprises three tonnage capacities, 1-, 2- and 4-ton. Featured is great flexibility for general shop use or for conversion from one type of operation to another. They are adapted to assembly work, push-broaching or pull-broaching, and may be converted from bench to pedestal types.

Two-unit construction is used in the pedestal types. Thus, the bench type press is rigidly bolted to a reinforced base to form the pedestal type. Platens are counterbored concentric with the ram, permitting ready installation and locating of fixtures in line with the ram movement on the machine.

The base below the platen is slotted and relieved to permit ready use of the press for assembly work. The sides of the slot are machined in relation to the axis of the ram to equalize clearance for fixtures on both sides. Ample daylight and stroke allow for fairly large work.

Direct drive electric motors, vertically mounted in the column of the machine, furnish power for the hydraulic operating mechanism. Motors are for 50 or 60 cycles. Stroke is altered by changing the stop collars. The machines will stop both top and bottom of each stroke, or at the top only, with automatic return at the bottom.

For broaching the pedestal models have a large coolant reservoir, fitted with chip strainers, the chips being removed through the door in the front of the base. A centrifugal coolant pump is externally mounted on the rear of the base, driven by individual motor.

For pull-broaching, the platen is bored and provided with long guide bushings, which serve as guides for the yoke guide rods which extend into the base of the machine, the yoke having a broach puller at the lower end. All this provides for a longer maximum stroke than previously.

Normal ram speed is 30 f.p.m., adjustable for less values. Other accessories are variable pressure control, pressure gage and dual controls.

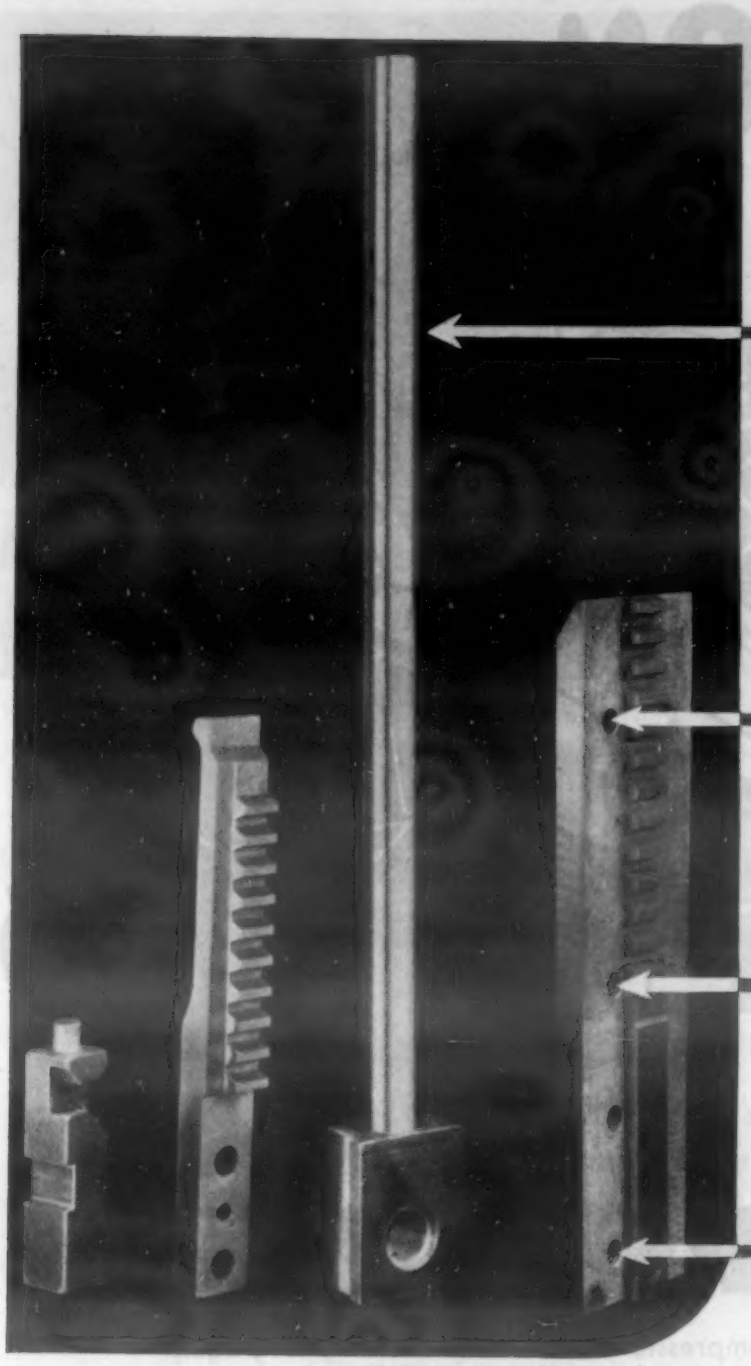
IS ALREADY IN PROGRESS AT KROPP FORGE

We are still producing a tremendous volume of hammer, drop and upset forgings for the war machine and will continue to do so until V-day. Today, with invasion under way and various armament assignments completed, certain facilities at the "world's largest job forging shop" are available for civilian applications which are recognized as essential. Too, production on certain classes of forgings can be started as soon as the forging steel can be procured.

Forgings have proved their worth in the present war as never before. Through their broader use, added stamina has been imparted to American-built planes, tanks, ships and other armament. It is forgings which withstand the terrific tensional, torsional and compression stresses to which fighting equipment is subjected.

Designers of postwar machines and equipment should likewise plan on a more extensive use of forgings, which provide metals at their ultimate strength. Their use conserves metal, weight and space by permitting the use of lighter section parts. Forgings require less time to machine and finish, and facilitate rapid assembly through welding adaptability. Forgings provide maximum resistance to shocks and stresses, supplying the high fatigue resistance which underlies dependable performance and long service. When you need flat die, drop or upset forgings, call your nearest Kropp engineering representative or send blueprints direct for immediate quotation.

KROPP FORGE COMPANY
5301 W. Roosevelt Road, Chicago (50), Ill.
Engineering Representatives in Principal Cities



In descaling, outside surfaces are often cleaned more quickly than tiny recesses. But when you descale by the Bullard-Dunn Process, this does no damage. A protective coating is deposited as the part is cleaned—so the base metal is never harmed.

This is but one of the unique advantages of this improved Electro-Chemical method of descaling. Today it lowers costs and increases output in many modern plants making vital munitions. Tomorrow it will put you ahead of your competitors in the race for peace-time markets. Write today for booklet.

THESE ADVANTAGES TOO!

- **Fast**
- **Economical**
- **Labor Saving**
- **Produces Chemically Clean Surfaces**
- **No Dimensional Changes**
- **Easy to Operate**
- **Long Solution Life**
- **Cleans Out Recesses**

BULLARD-DUNN
DIVISION OF THE
BULLARD COMPANY BRIDGEPORT 2, CONNECTICUT

A Correction

A Bausch & Lomb Optical Co. advertisement entitled "Pattern for Postwar Progress" appeared in the August issue of this publication. The first paragraph should have read:

Here are the portraits of two of today's metals—brass and steel. From these and other metals, many of them developed as a result of wartime needs, will come the new alloys of tomorrow.

Bright Alloy Plate

A new bright alloy plating process, involving an alloy of copper, tin and zinc, is being sponsored by *Hanson-Van Winkle-Munning Co.*, Matawan, N. J. It is used as a protective coating on electrical products.

The process is novel in that alloy anodes of the same composition as the deposit have been perfected. Thus, the metal concentration of the bath can be maintained automatically. The deposits come from the solution bright and are blue-white in color.

The plating solution is of ordinary chemicals, with an organic addition agent having wetting properties. Special formulas are provided for still and barrel plating. Nickel, gold, silver, copper and other metals can be plated over or under this alloy deposit.

Chromium can be applied over the deposit after a light anodic cleaning to remove the film from the wetting agent. Usually special rinses or treatments are not needed.

The deposit is readily soldered, using rosin as a flux. Alloy-coated parts can be soldered more readily than tin-coated parts which have become oxidized. When applied over copper and brass, a thickness of 0.0002 in. will withstand a 200-hr. salt spray test. Tests on radio frequency instruments show that 0.0002 in. of the bright alloy deposit give as much protection as 0.0005 in. of nickel.

The alloy is brittle in heavy coatings and is seldom used thicker than 0.0005 in. It is harder than nickel, about 0.0002 in. being equivalent to 0.0005 in. of nickel. When applied thin it can be formed without flaking. It is non-magnetic in an electrical field. It both decorates and protects fine instruments. The throwing power of the solution is superior to most processes. Its reflectivity approaches silver. When applied to steel for corrosion resistance, a copper undercoating is needed.

Regular copper plating equipment is suitable, including unlined steel tanks. Steel coils heat the solution to 140 to 150 F. for still plating and to 150 to 160 F. for barrel plating. With more than one tank operated from a generator on a 6-v. line, a 2-v. drop rheostat is used. Usually the rheostat should be based on a cathode current density of 15 to 20 amp. per sq. ft. of surface area.

● A new line of smooth-flowing arc welding electrodes, with quiet arc characteristics, is sponsored by the *Allis-Chalmers Mfg. Co.*, Milwaukee 1. Both a.c. and d.c. types, they use the standard A.W.S. number and color.

They said it couldn't be done

PRIOR to the present emergency it was considered an impossibility to produce narrow strip to exacting specifications on any of America's wide strip mills;- but Youngstown's skilled workmen, chemists and metallurgists proved otherwise.

Machine gun belts of webbed fabric cluttered up precious space inside planes and tanks, and were apt to jam gun mechanisms at critical moments. So American engineers designed a simple little clip of high carbon steel. Each clip interlocks over two cartridges, and links them into a continuous flexible belt, so unvarying in dimensions that it flows through a 50 caliber gun like "greased lightning",--as high as 800 shots per minute.

For these links, Youngstown is supplying steel strip--has already furnished enough to make many, many millions of cartridge belt clips. Every coil of this strip must meet rigid specifications--.001 inch variation in gauge in each coil and not over .002 for all strip furnished--exactly the right tensile strength, elasticity and forming properties.

By producing flat-rolled steel to these exacting specifications for Victory, Youngstown has proven its ability to fulfill your peace time requirements in the post-war period.

YOUNGSTOWN

THE YOUNGSTOWN SHEET AND TUBE COMPANY

YOUNGSTOWN, OHIO

Manufacturers of

CARBON - ALLOY AND YOLOY STEELS

Pipe and Tubular Products - Sheets - Plates - Conduit - Bars - Electrolytic Tin Plate - Coke Tin Plate - Rods - Wire - Nails - Tie Plates and Spikes - Alloy and Yoloy Steels.

★

HOW MANY PIECES BEFORE REDRESSING?

The Profilometer Gives the Answer!

It is possible, through use of the Profilometer, to schedule a dressing of the wheel following the production of a specified number of parts in any individual grinding setup.

In production grinding of parts, much depends on the proper dressing of the wheel:

- correct surface finish
- maintenance of accurate dimensions
- cutting down grinding time per part
- steady production on final finishing operations.

Because of the many variables in every grinding setup — condition of machine, material, grain and grade of wheel, etc. — it is difficult to determine exactly how many pieces can be ground for each dressing of the wheel — difficult, that is, without the Profilometer.

★

A definite solution to this problem is provided by taking Profilometer readings of parts as they come from the grinder. As the wheel wears, the changes in its performance are reflected in the Profilometer readings.

Use of the Profilometer for this purpose has shown that in any particular setup, the number of parts produced per dressing of the wheel remains practically constant.

Profilometer Has Wide Range of Uses . . .

The brief description above outlines but one of the many ways in which manhours, materials, and money may be saved through use of the Profilometer in measuring average surface roughness.

For more information on surface roughness and the Profilometer equipment for measuring it, write for the booklet *Practical Surface-Roughness Measurement*, mentioning this magazine.

PHYSICISTS RESEARCH COMPANY

343 SOUTH MAIN STREET · ANN ARBOR, MICHIGAN

● The new "Ashcroft Duraswitch," used in combination with the Ashcroft gage, is announced by *Manning, Maxwell & Moore*, Bridgeport, Conn. The gage has slide rule dial easily readable for accurate adjusting of the switch to control point. This combination saves space, eliminates extra fittings, improves appearance. Series E-100 are for pressure; E-200 for pressure and temperature and other combinations.

All-Purpose Sawing Machine

New materials constitute a wide range of characteristics. Some are abrasive, others sticky, while still others are soft, spongy or hard. Hence, extreme versatility is demanded of the machine tool that shapes all these materials. To meet these conditions a high-speed sawing machine, the DoAll

Zephyr, has been brought out by *Continental Machines, Inc.*, 1301 Washington Ave. S., Minneapolis 4.

This metal shaping contour machine maintains control of high speeds, has rigid construction and uses all purpose, narrow, precision cutting band saws. It features a 36-in. throat depth and 20-in. work thickness capacity, with speed ranges of 1500 to 10,000 ft. per min. The speed range is controlled by a "Speedmaster" variable speed pulley. A "job selector dial" shows the saw control factors for the shaping of 104 basic materials.

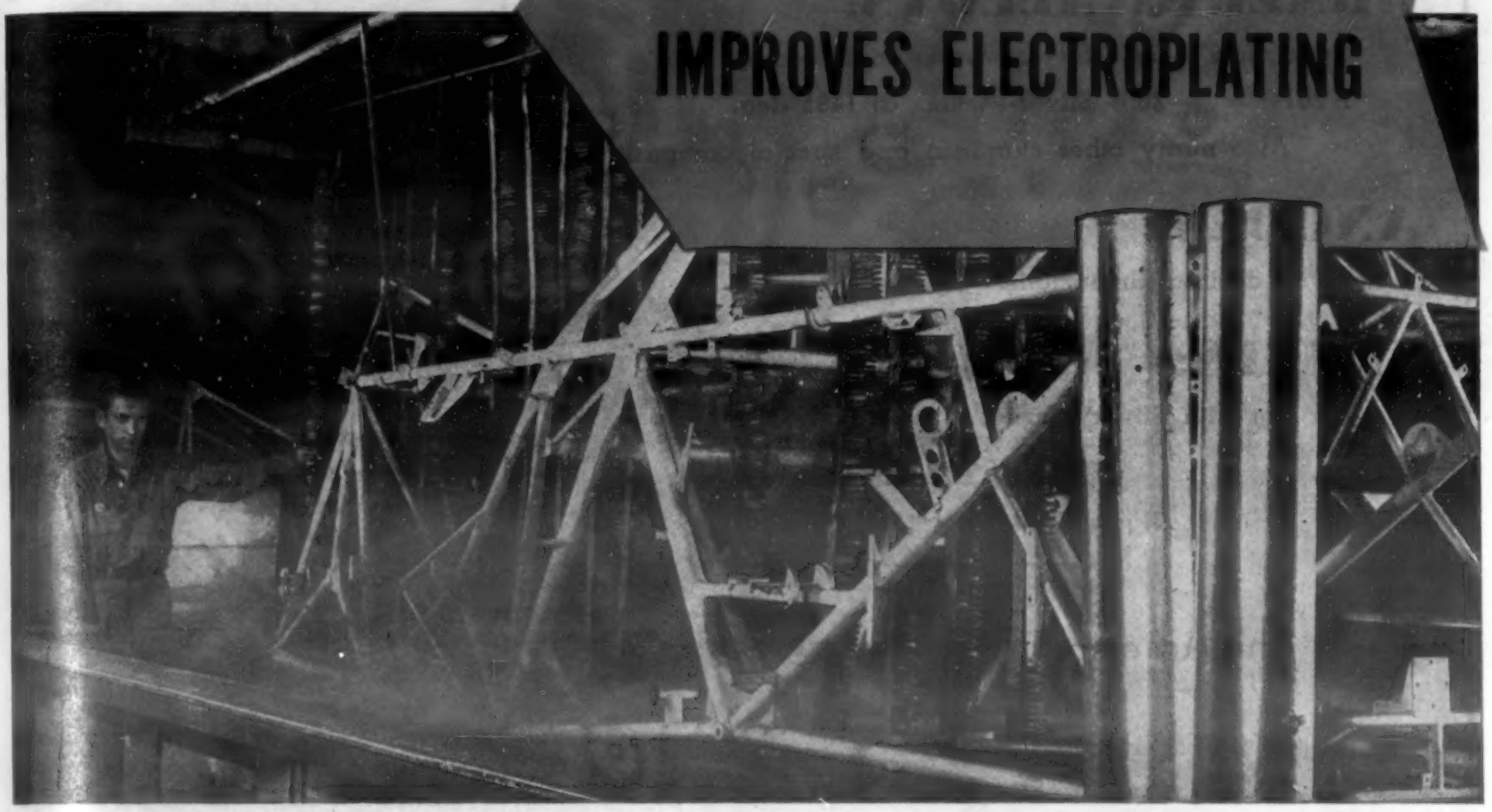
Its versatility extends to the use of various kinds of band saws, such as spring tempered, metal cutting and the new buttress tooth saw, since its speed range is wide enough to provide the most efficient cutting speed for all types of saws. Standard equipment includes a 10 h.p. variable speed drive, a 30 by 30 in. work table with secondary table extension 17 by 20 in.

● *The Alloy Rods Co.*, York, Pa., has developed a new stainless steel arc welding electrode, one rod, that performs equally well on a.c. or d.c. in all positions. All stainless steel analyses are now available for a.c. and d.c. They have exceptionally low spatter loss, easily removed slag and instant arc establishment. Welds made in the flat, vertical and overhead positions are of accepted contour.

Prosolv *B*

offers outstanding advantages

NEW TURCO CLEANER IMPROVES ELECTROPLATING



APPROVED FOR THE BULLARD-DUNN DESCALING PROCESS

Equally effective in still tank and electro-cleaning

So positive are the advantages of Turco Prosolv *B* that prominent electroplaters have switched to this new cleaner immediately following tests *although they had considered satisfactory the materials they had been using.*

Turco Prosolv *B* insures the chemical and physical cleanliness that is essential to 100% bonding to steel of zinc, cadmium, chromium and other plate. It removes every trace of oil, grease, smut, paint and rust preventive compound. It contains no soap; leaves no deposit. Rinsing is complete, even though parts may have dried.

A highly concentrated product, Turco Prosolv *B* is 100% active. Every particle works; there is no waste.

As this new cleaner is effective in both still tank and electro cleaning, it simplifies stocking and plant procedure where both processes are employed.

Try Turco Prosolv *B* for stripping tin deposits formed during the Bullard-Dunn descaling process. A standard cleaning tank may be used for this. Call the Turco Field Service Man for details on this specially formulated electro and still tank cleaning material which is doing such a notable job the nation over. Write today.

Follow Prosolv *B* with Turco Descaler This second step in preparing steel for plating is as necessary to a perfect job as the primary cleaning operation in Prosolv *B*. Any rust, mill, welding or heat-treat scale will prevent bonding of plate. Turco Descaler removes these without attaching the base metal. Thus the combination of Turco Prosolv *B* and Descaler insures quality plating at low cost. Let us furnish full details.

Rust Bar treatment for unplated portions. Partially plated parts, if treated with Turco Rust Bar, are well protected from corrosion during indoor storage although subjected to severe conditions. A thin film of Rust Bar is resistant not only to airborne water vapor, but also to corrosive gases and other types of corrosive agents.

TURCO

Turco PRODUCTS, INC.

Write Dept. A-7

SPECIALIZED INDUSTRIAL CHEMICAL COMPOUNDS

MAIN OFFICE AND FACTORY: 6135 SOUTH CENTRAL AVE., LOS ANGELES 1 • SOUTHERN FACTORY: 1606 HENDERSON STREET, HOUSTON 10, TEXAS • CHICAGO OFFICE AND FACTORY: 125 WEST 46TH STREET, CHICAGO, ILL. • SERVICE MEN AND WAREHOUSE STOCKS IN ALL PRINCIPAL CITIES

SILVER

BRAZING ALLOYS:

"Readyflow"—56% Silver—works at 1165 deg.

B 201 —20% Silver—works at 1485 deg.

Also many other standard and special compositions.

ANODES:

Of all desired dimensions.

FLUXES:

For use with Silver Brazing Alloys.

Write for booklet "MA"

The American Platinum Works

N. J. R. R. AVE. AT OLIVER ST.

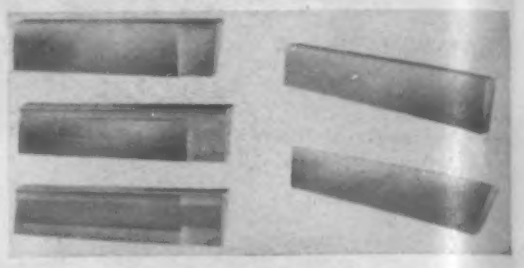
Newark, N.J.

EST. 1878

● A new improved welding goggle, providing better protection and greater comfort, is announced by *American Optical Co.*, Southbridge, Mass. Called the "AO Duraweld," they have newly designed eyecups, anatomically molded for the right and left eye. They have larger, more comfortable edges, rounded to fit flush against the contour of the face. Improved nasal fitting prevails. Better ventilation helps prevent fogging. It is impossible for stray light rays or sparks to reach the eyes. They are made in several shades, depending on the work.

Grooving and Cutoff Tools

Grooving and cut off tools of Stellite cobalt-base alloy that were formerly regarded as specials, made to individual specifications, have now been made standard and put in stock. Produced by *Haynes Stellite Co.*, unit of *Union Carbide & Carbon Corp.*, 30 E. 42nd St., New York 17, both



types may be obtained in either 98M2 or Star J-metal alloy, with the former especially recommended for steel.

The grooving tools are finish ground and lapped to specified tolerances, while the cut-off tools are ground to size, but not lapped unless specified. Grooving tools are furnished either plain, channel or I-beam for operations on cast iron, aluminum, brass, bronze and steel. Side lands are lapped to give maximum tool life. To resharpen, one merely grinds the cutting end, maintaining the front clearance angle.

Cutoff tools are made in two styles, 1 and 2. Both are of double-bevel type, the tapered sides providing side cutting clearances. In No. 2 a 6° angle is incorporated in the top and bottom edge for adaptability to certain cutoff tool holders. Both styles will cutoff tubing, cylinders or hollow forgings of cast iron, brass, bronze, aluminum and some types of steel.

In the accompanying photograph, at the left, are plain, channel and I-beam styles; at the right cutoff tools in Styles 1 and 2.

OILY or greasy films which grip metal surfaces tightly are quickly penetrated and broken up into small droplets by the balanced silica-alkali content in the Metso silicated cleaners. Their emulsifying power is outstanding in the removal of tight-clinging grease and oil.

Then the efficient suspending action of the silicated cleaners takes over, with the result that the dirt is kept free of the clean metal.

Know more about the silicates' emulsifying property. Discussed in the bulletin "Detergent Value of Sodium Metasilicate" available on request.

PHILADELPHIA QUARTZ COMPANY
Dept. C, 125 S. Third St., Philadelphia 6

metso Cleaners

METSO GRANULAR U. S. Pat. 1898707 METSO 99 U. S. Pat. 1948730, U. S. Pat. 2145749

● A new water-resisting, hand protective cream for workers with water-soluble cutting oils, dilute acids, alkalis and other water-chemical mixtures, is announced by the *Finishes Div., E. I. duPont de Nemours and Co.*, Wilmington 98, Del. Called "Pro-Tek No. 2," it forms a flexible, slightly greasy film on hands and arms. One application lasts 3 to 4 hr. It contains a high percentage of lanolin, which closely resembles the natural oils of the skin.

NEW BULLETIN

Featuring

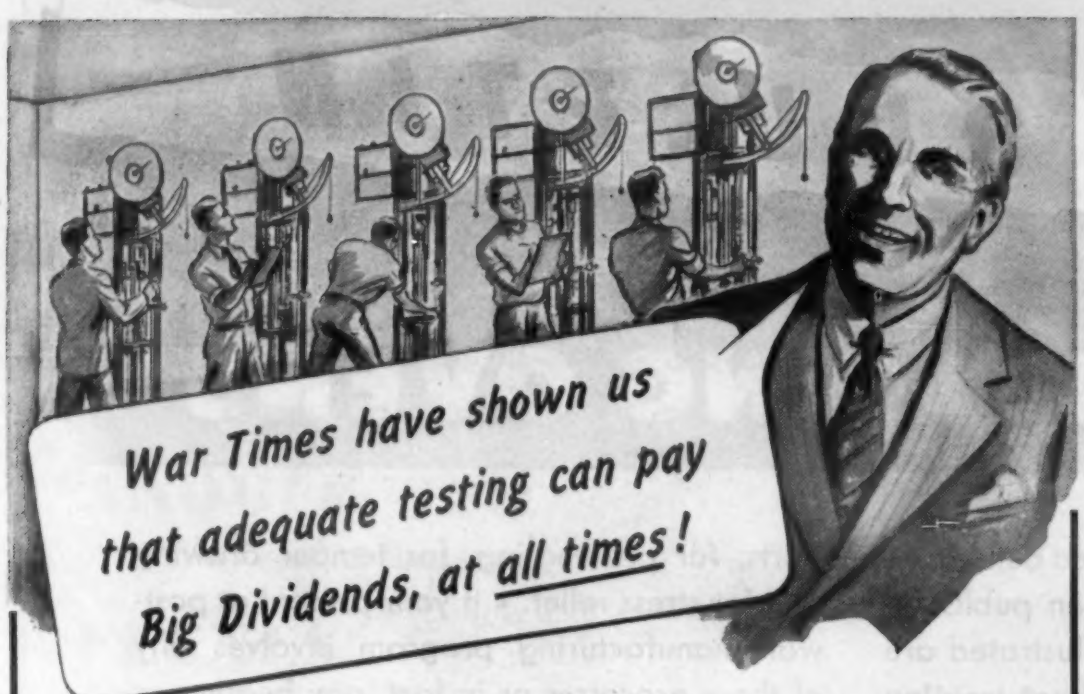
HEAT TREATING OVENS

A new twelve page fully illustrated bulletin on heat treating ovens has just been published by Young Brothers Company. Illustrated are typical examples of ovens for heat treating aluminum and magnesium parts, for ageing, stabilizing and hydrogen relief of plated parts, for pre-heating, for temper drawing and for stress relief. • If your present or post-war manufacturing program involves any of these processes or in fact, any heating or baking at temperatures up to 1000° F., you will find material of interest here.

YOUNG BROTHERS COMPANY

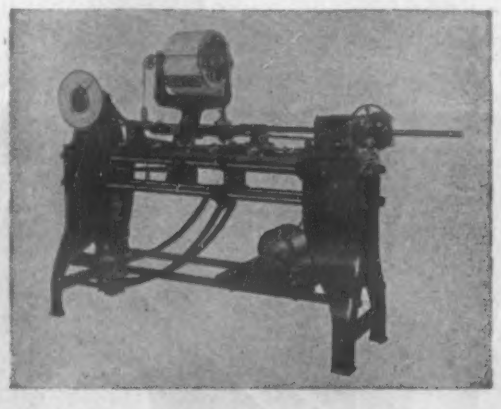
6514 MACK AVENUE • DETROIT 7, MICHIGAN

ESTABLISHED IN 1896



*Scott Testers protect and promote production

Whether conditions are those of war-time urgency or peace-time competition, the advantages of an Adequate Testing Routine are many and valuable. Testing facilitates research, insures purchasing, speeds production and proves quality. The 60 models of *Scott Testers span the needs of wire and strip testing for tensile, hysteresis, twist, flexing, compression-cutting of rubber coating, etc., etc., with capacities from finest filament wire to 1 ton tensile. A useful advantage of our machines if the "picturized" form of result graph, ideal for quick comparison and as a record for future reference.



Model Q-7 Scott Tester. Heavy duty tensile tester for wire, with capacity up to 2,000 lbs.

Request Circulars

HENRY L. SCOTT CO.

65 Blackstone St. **SCOTT TESTERS** Providence, R. I.

*Registered Trademark

Scott Testers — Standard of the World

● A new combination automatic reaming and burring profiler for handling tubes up to 6 in. O.D. and lengths from 3 ft. to 60 ft., or longer, is announced by *Pines Engineering Co.*, Aurora, Ill. Production of 200 to 400 tubes per hr. can be obtained on end facing and burring, and 100 to 200 where inside reaming is needed.

Ultra-Pure Iron for Spectrography

Scientists are now engaged in "mass production" of ultra pure iron at the rate of 1,000 lb. a year—an iron that contains only one ounce of impurities in 1000 lb. and provides a yardstick against which the composition of steel, aluminum, magnesium and other metals may be quickly and accurately gaged.

The pure iron is made in induction furnaces at the East Pittsburgh Works of *Westinghouse*. Formed into rods the size of a lead pencil, the 99.99% pure iron is used in steel mills, war plants and laboratories throughout the Allied world.

The rods are put in a spectrograph where the iron is heated with an electric arc. This causes the iron to radiate light-rays which print a wave-length picture, a series of vertical lines, on photographic film.

These pictures are then compared with similar pictures of the metal being tested, enabling determination of the composition of the latter swiftly and accurately. The spectrographic picture of iron contains a large number of lines, making it easy to identify the test metal's components.

Until this new process, the best standard was only 99.90% pure. The new superrefinement is accomplished by two means: Electrolysis, and by heating the metal in an induction furnace in a hydrogen atmosphere.

In the first process, a bar of high grade iron and a bar of lead are put in a solution of iron salts. An electric current is passed through, breaking down the iron bar and depositing a spongy mass of nearly pure iron on the lead bar, which is removed from the lead and put in an enclosed furnace through which hydrogen gas is pumped.

Around the outside of the furnace is a copper coil, carrying a high frequency electric current. Waves from the coil set up an electric current in the iron itself. The electrons of the iron atoms are "shaken up" so vigorously that the metal becomes hot and literally melts itself. Carbon and oxygen in the metal combine with the hydrogen gas and are removed, leaving ultra-pure spectrographic iron.

● A new safety industrial pair of goggles, weighing only 0.96 oz., is announced by the *Chicago Eye Shield Co.*, 2300 Warren Blvd., Chicago. This "Cover-Lite" model has an all-plastic frame. It is for both sexes, may be worn over regular spectacles, and rests lightly on the face. Lenses are replaced very simply.

LATROBE

Molybdenum

HIGH SPEED STEELS

for CUTTING TOOLS

EACH of these steels assures you of Latrobe's distinctive qualities—superior heat-treating properties and longer tool life. Each is ideally adapted to its particular use.

DOUBLE-SIX

C	Cr	W	Mo	V
.84	4.15	6.23	5.10	1.85

TATMO

C	Cr	W	Mo	V
.79	3.96	1.55	8.30	1.15

T.N.W.

C	Cr	W	Mo	V
88	3.90	—	8.00	1.90

HV-6

C	Cr	W	Mo	V
1.15	4.10	6.15	6.15	3.10

Exacting metallurgical control and years of experience in the manufacture of Tool Steels make it possible for LATROBE to produce the highest quality in molybdenum high-speed steels. ● Compare the analyses of these four steels and note the range in tungsten, molybdenum and vanadium content, thus affording the user the characteristics of toughness and abrasion resistance necessary to meet the requirements of varying metal-cutting problems.

Our service department will gladly help you on problems of heat treatment, selection or application Write

LESCO

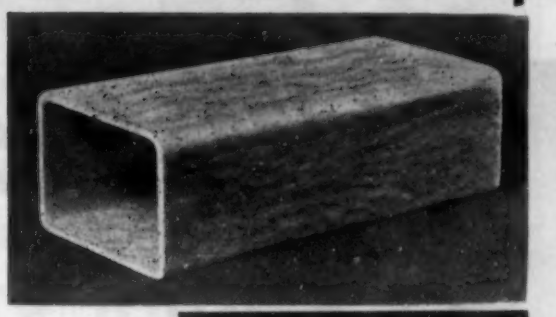
Latrobe ELECTRIC STEEL COMPANY

MAIN OFFICES *and* PLANT •• LATROBE • PENNSYLVANIA

VITREOSIL

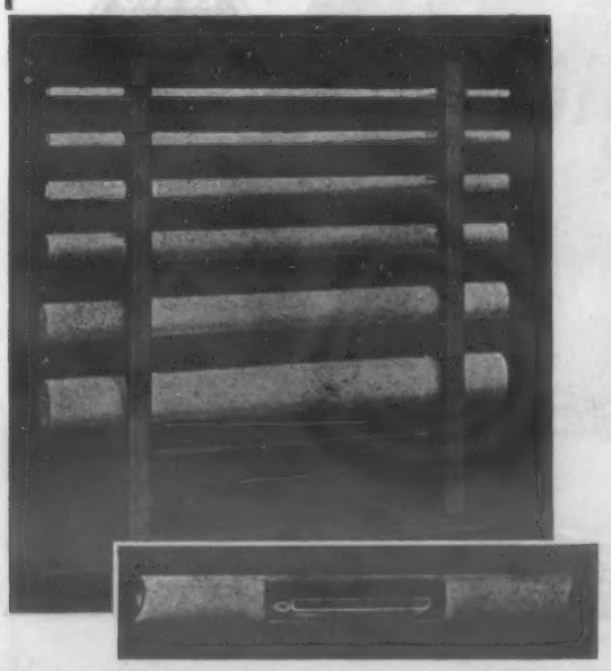
(Vitreous Silica)

The Ultimate
CERAMIC
for



- SINTERING AND CHLORIDIZING
- HEAT TREATMENT OF METALS
- EVAPORATING, CONCENTRATING AND CRYSTALIZING ACID SOLUTIONS
- CONTROLLED ATMOSPHERE TECHNIQUES
- HIGH TEMPERATURE ELECTRICAL APPLICATIONS
- GAS, COAL AND COKE ANALYSIS
- PRECIOUS METAL REFINING
- METALLURGICAL ANALYSIS AND RESEARCH

VITREOSIL is superior to both glass and porcelain for these and many other exacting applications in metallurgy . . . Vitreosil possesses the highest temperature shock resistance of any ceramic material. . . . It is practically immune to the severest acid conditions, is free from metallic impurities—nonporous—light in weight, and has high electrical resistivity at elevated temperatures. VITREOSIL is suitable for continuous use up to 1000-1100°C.



VITREOSIL is available without restrictions, in the following forms:

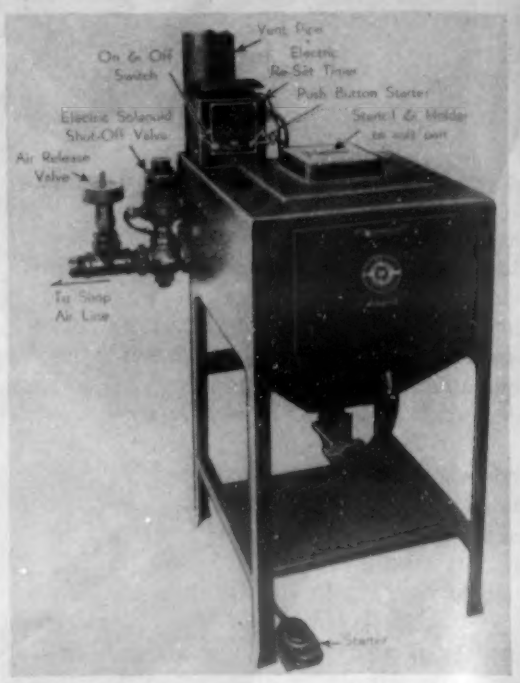
- CRUCIBLES
- MUFFLES
- RETORTS
- PIPES and FITTINGS
- TANKS
- TRAYS
- IMMERSION HEATERS
- COMBUSTION BOATS
- DRAWN ROD and TUBING

For explicit data and prices, write for bulletins.

THE THERMAL SYNDICATE, LTD.
12 EAST 46th STREET, NEW YORK, N. Y.

Marking Unit for Delicate Parts

A new marking machine for marking precision and delicate parts, which must not be marred or distorted, is announced by *Jas. H. Matthews & Co.*, 3842 Forbes St., Pittsburgh 13. Called the "Airgrit," it marks metal, glass, fibre or plastic parts by



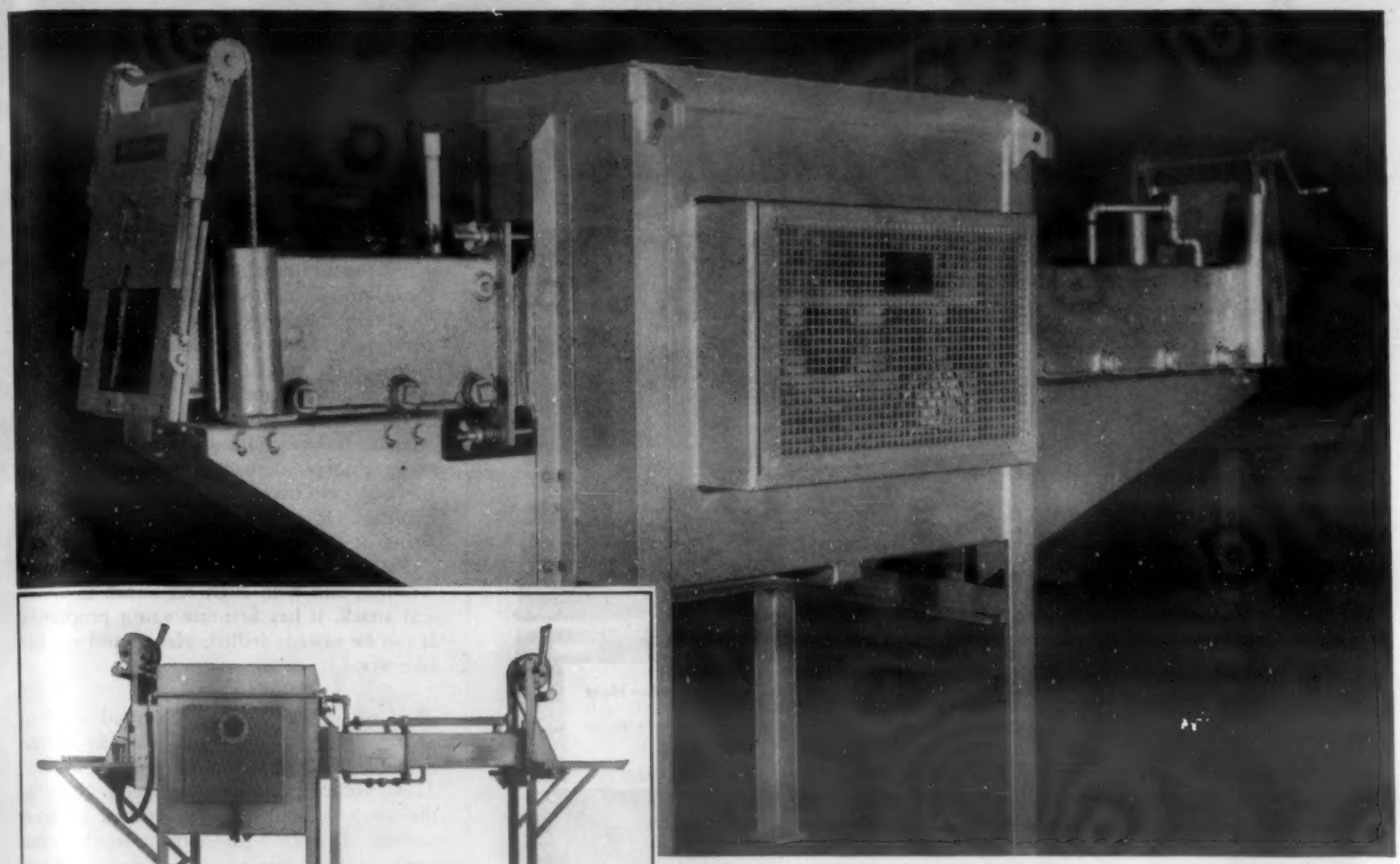
a short blast of fine grit material against rubber or celluloid stencil masks upon which the work is placed.

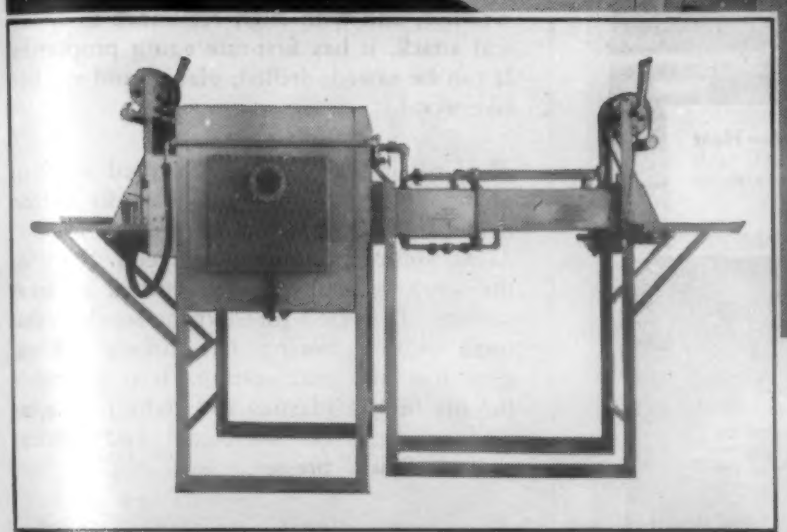
The desired marking is cut into the stencil and the resulting mark is a light, clear-cut impression, without liquid, that might cause rust, and without burrs. Parts are marked as fast as handled by the operator. It is operated by air pressure, similar to sand blasting, except that it is modified for very fine work. It works best on 5 to 8 lb. air pressure at the nozzle, using 30 cu. ft. of air per min.

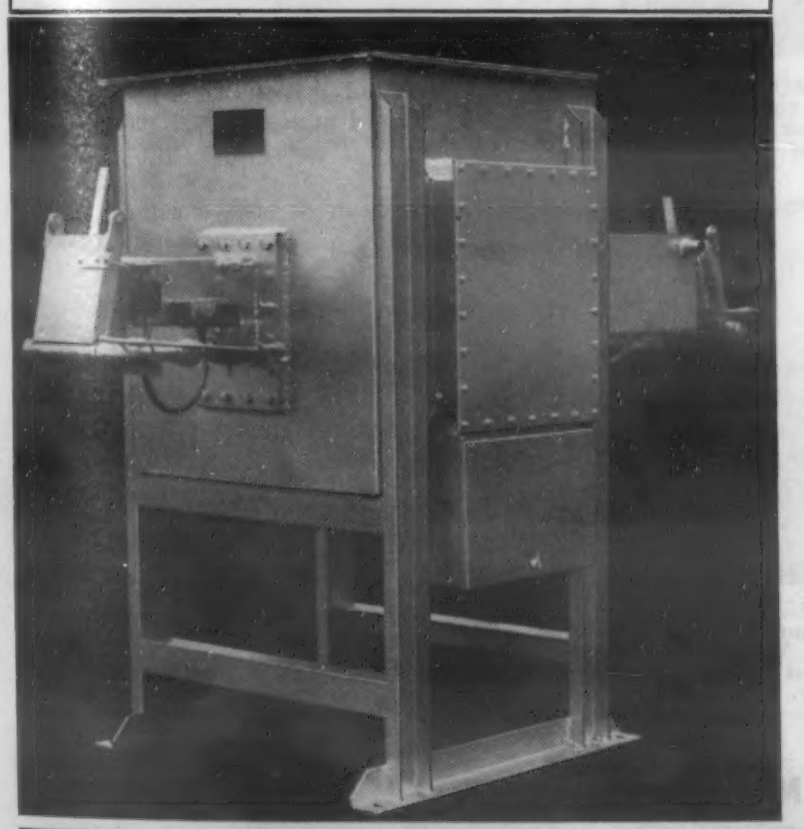
The unit has an electric solenoid valve and timing unit to fix the length of blast and provide uniformity of marking. Most parts are marked with a 2 sec. blast, but provision is made for any interval from ¼ to 14 sec. The correct interval is learned by experiment. With each unit 25 lb. of No. 180 grit is included.

Stencil masks can be furnished in celluloid, patented rubber or rubber-covered brass. Best results are with characters 1/16 in. or larger. Maximum area of the mark produced with a ⅜ in. I. D. nozzle unit is ¾ in. square.

● An attachment for electric drills, providing a portable power saw and file, called "Saw-Chief," is announced by *Chicago Precision Equipment Co.*, 919 N. Michigan Ave., Chicago 11. It saws into metals, plastics, etc. by placing an ordinary hack saw blade in the holder with the teeth toward the operator. By inserting a file in the holder it becomes an automatic file. The unit can be impelled by a compressed airline or flexible shaft. Features are: Balanced ball bearing construction and pistol grip handle. It will attach to any electric drill with a ¼-in. chuck.







More efficient because They are "Globar" powered

This trio of furnaces, designed particularly for sintering powdered metals, really owe a great deal of their success to "Globar" Electric Heating Elements—because these elements have a lot to do with creating such necessary operating conditions as:

1. Close control of temperatures which range between 1800°F. and 2750°F.
2. Independent and accurate control of atmosphere.
3. Uninterrupted production.

You will be interested in knowing that these "Globar" powered furnaces are also definitely ideal for bright annealing of stainless steel parts, reducing metallic oxides, hydrogen brazing and other heating processes demanding temperatures up to 2750°F.

While we do not manufacture furnaces we do have a wealth of engineering data on many types and applications of "Globar" heated electric furnaces. Please consult our Engineering Department. The Carborundum Company, Globar Division, Niagara Falls, N. Y.

"Globar" Heating Elements by CARBORUNDUM
TRADE MARK

(Carborundum and Globar are registered trade marks of and indicate manufacture by The Carborundum Company)

It takes the best TO MAKE THE BEST

PLAN NOW
FOR POST-WAR PRODUCTION

CONTINUOUS WALKING BEAM—Heat treats material up to forty feet in length with minimum effort and maximum safety.

CONTINUOUS BRIGHT ANNEALING—Equipped with woven wire belt, cooling chamber, atmosphere unit and variable speed drive for heat treating stampings.

R-S QUALITY PRODUCTS SINCE 1908

CONTINUOUS CONVECTION—Exceptionally uniform and close temperature control (400 to 1300°F.) Variable speed drive. Easy to load and unload. Better than average delivery.

FURNACE DIVISION

R-S PRODUCTS CORPORATION

4522 Germantown Avenue • Philadelphia 44, Penna.

ANNEALING CONVECTION ROTARY HEARTH SALT BATH FORGING
CONTINUOUS CONVEYOR PLATE AND ANGLE HEATING METAL MELTING CAR HEARTH

R-S Furnaces of Distinction

BUY WAR BONDS

New Versatile Material

Permission has now been granted to release information on "Cell-Tite," the ebony-like, cellular rubber material from which propeller fairings are made, for which is claimed the best strength-weight ratio of any material produced commercially. It is made by the *Sponge Rubber Products Co.*, Derby, Conn.

By the addition of fairings to propellers, more air is churned back onto the engine to obtain marked decrease in engine temperature. Made in various weights, from 8 to 20 lb. per cu. ft., Cell-Tite is filling many industrial needs.

Besides great strength, hardness and light weight, it has more buoyancy and lower water absorption than cork; it has excellent thermal, electrical and sound insulation qualities. It can be molded to almost any shape or form.

Practically impervious to water and weather, and with high resistance to chemical attack, it has first-rate aging properties. It can be sawed, drilled, planed and worked like wood.

● Utilizing standard high-speed steel or carbide bits, a single universal fly cutter, made by *Newfield Machined Parts Co.*, 7160 Melrose Ave., Los Angeles 46, does the work of many special cutters at great savings. It is used for slotting, straddle and form milling, boring, flat surface milling, gear, disc and gear cutting. It is adaptable for machining plastics and light metals, as well as steel, on horizontal and vertical mills and drill presses.

Air Hydraulic Gap-Type Press

A new air hydraulic, gap-type, speed press, adapted to stamping, riveting, assembly, forming, punching, cutting, etc., is announced by *Studebaker Machine Co.*, 1221 S. Ninth St., Maywood, Ill. Called the "Corsair," it has maximum pressure of 1¾ tons.

An inexperienced operator simply pushes down the hand (or foot) control, the ram quickly travels the set stroke from 1/32 in. to 2½ in. and delivers pre-selected pressure. The operator releases control and the ram retracts automatically.

Air cylinder and hydraulic pump units are built into the press body and are easily accessible. Extreme speed is a feature—or the ram can be slowed down to exact requirements. Tough materials can be given a fast blow and fragile materials a squeezing action to prevent shattering.

Surface Hardening at Machine Gun Speed!

with

-MEGATHERM*-

INDUCTION HEATING

Here is a history-making application of a Megatherm Induction Heating Unit.

On this typical production line setup, 75 bearing pins a minute are surface hardened.

This hardening is done after finish grinding has been completed.

In one high-speed operation the pins are hardened to Rockwell C 60—above file hardness—and costly finish grinding of hardened steel is avoided because scale and distortion are eliminated.

The pins are 2½" long and ½" in diameter, made of chromium molybdenum steel. To heat treat 4,500 bearing pins an hour costs approximately 50¢.

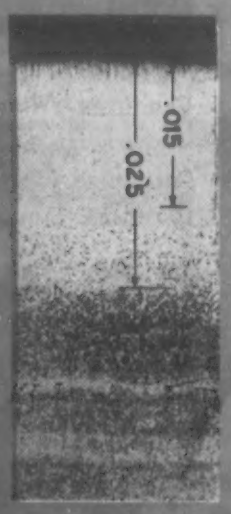
Each pin is heated above critical temperature in less than one second. Quick heating and quenching prevents scaling or distortion and gives accurate control over the hardened case depth.

This is only one of the many new applications of Megatherm Heat in the metal industry. Pieces as small as ⅛" diameter or bearing surfaces up to 6" are handled as easily, all with Megatherm.

More information on how Federal's Megatherm High Frequency Heat can save you money on your production line is yours for the asking. Check Megatherm now.

This Microphoto

magnified 100 diameters shows the hardened surface developed on bearing pins. The white portion is that of the hardened outside layer which extends to a depth of 25 thousandths of an inch. At no point in the zone between the fully hardened case and the unhardened core was there any softening or tempering.



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Federal Telephone and Radio Corporation

INDUSTRIAL ELECTRONICS DIVISION

AN IT&T ASSOCIATE

Newark 1, N. J.

* REG. U. S. PAT. OFFICE

5 CASES WHERE KENNAMETAL INSERTS *Take a licking and like it!*

Condition: Grinder table had to be resurfaced frequently to maintain true grinding of tool angles.

Correction: Kennametal inserts provide true, flat surfaces that show no appreciable wear after many months' service.

Condition: Worn sliding surfaces of abrasive saw rest allowed shank steel to wobble, causing uneven cut-off.

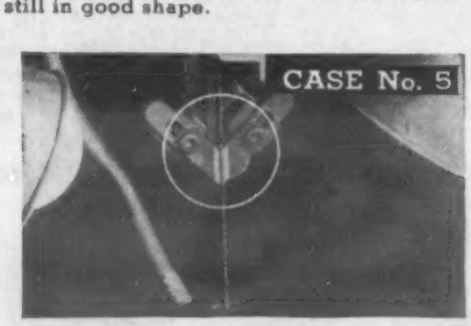
Correction: Inserts of Kennametal make smooth surface that outwears steel up to 100 times.

Condition: Steel parts of vise clamping mechanism badly galled by twisting action.

Correction: Kennametal discs, at abutting points, minimize wear; permit jaw to be closed securely, opened readily with less effort.

Condition: Wire cleaning brushes cut deep into steel leveling guides in less than one day.

Correction: Kennametal inserts resist the abrasion . . . after months' service, are still in good shape.



Condition: Steel surfaces of band saw guides wore quickly, allowing saw to weave and cause uneven profiling.

Correction: Inserts of wear-resistant Kennametal provide non-galling surfaces that guide the saw straight and true.

WHAT'S YOUR CASE?

If the service life of your products or production machinery is shortened by excessive wear . . . incorporate extremely hard, non-galling Kennametal parts at critical points. Kennametal is available in a variety of standard shapes (balls, discs, flat blanks), and it can be molded into almost any special form, limited only by reasonable proportions. Write for catalog information.

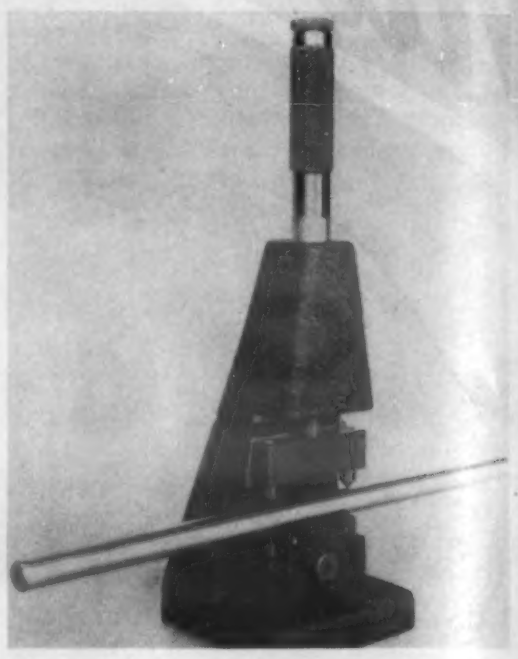
KENNAMETAL
SUPERIOR CEMENTED CARBIDES
KENNAMETAL Inc., LATROBE, PA.

● For both induction and dielectric heating loads a complete line of high frequency generators, with ratings of 1, 2, 5, 10 and 20 kw. in line with NEMA standards, is announced by *Westinghouse*. They are completely self-contained.

●

Gage Point Punch

A new gage point punch which is double-acting and on which impact force is adjustable for different materials, is announced by *Baldwin Locomotive Works*, Philadelphia. It has four features: It marks four uniform centers on the specimen with

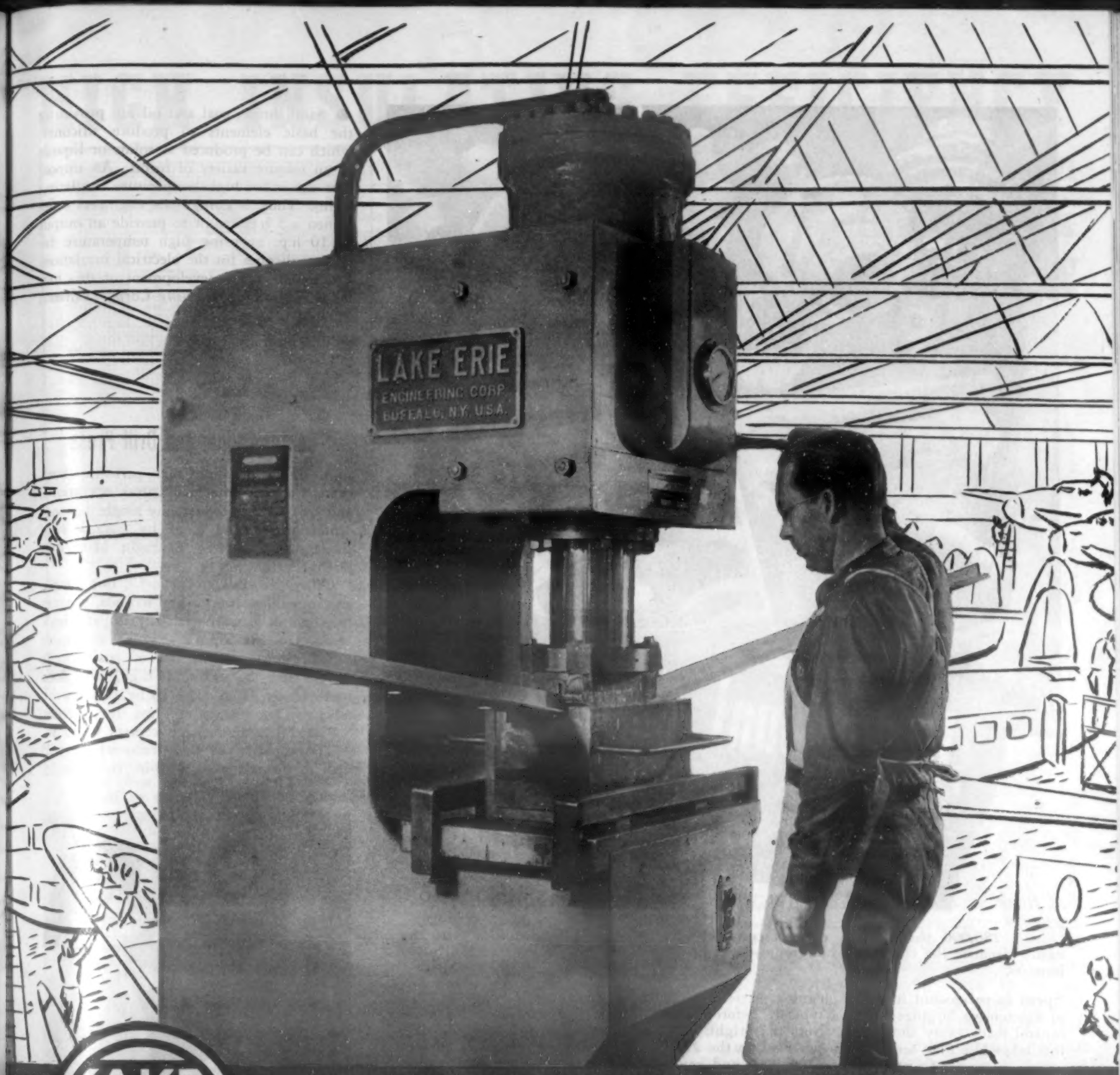


one push of the handle, it automatically centers either round or flat specimens, the impact force is applied manually by an adjustable detent which eliminates the use of a hammer, and impact and size of punch marks are adjustable to suit soft and hard specimens.

The upper punch holder, guided in a heavy frame, is attached to the impact-adjustable handle. The entire upper punch point assembly is spring supported to keep the gap between punch points open for the largest specimen.

When the specimen is placed on the support, the upper handle is pushed down until all punch points rest on the specimen. A continued push downward on the handle brings to a preadjusted compression a second spring within the tubular knurled handle, releasing potential energy to produce impact on the specimen.

● A full line of diamond tools, companion to their Super-Cut diamond wheels, is announced by *Industrial Abrasives, Inc.*, 3724 W. 38th St., Chicago 32. Twenty-two of the new tools are available in a variety of types to fit all standard grinding machines and individual uses—wheel dressers, gear grinders, thread grinders, radius and form dressing, boring tools, gage points, chisel edges and multiple set and cluster type dressers. Each diamond is individually selected for the use specified and is expertly set.



LAKE ERIE

***LAKE ERIE HYDRAULIC PRESSES** are available for specific problems other than for conventional stamping and forming. For example, Lake Erie straightening presses perform a wide range of bending or straightening operations involving round and square rods, bars, tubing and other shapes. **LAKE ERIE PRESSES** offer many advantages including: sensitive pressure control, fast operation, and ample tonnage to handle heavy materials.*

LAKE ERIE ENGINEERING CORPORATION • BUFFALO 17, NEW YORK

DISTRICT REPRESENTATIVES:

250 Park Avenue
New York 17, N. Y.

230 N. Michigan Ave.
Chicago 1, Illinois

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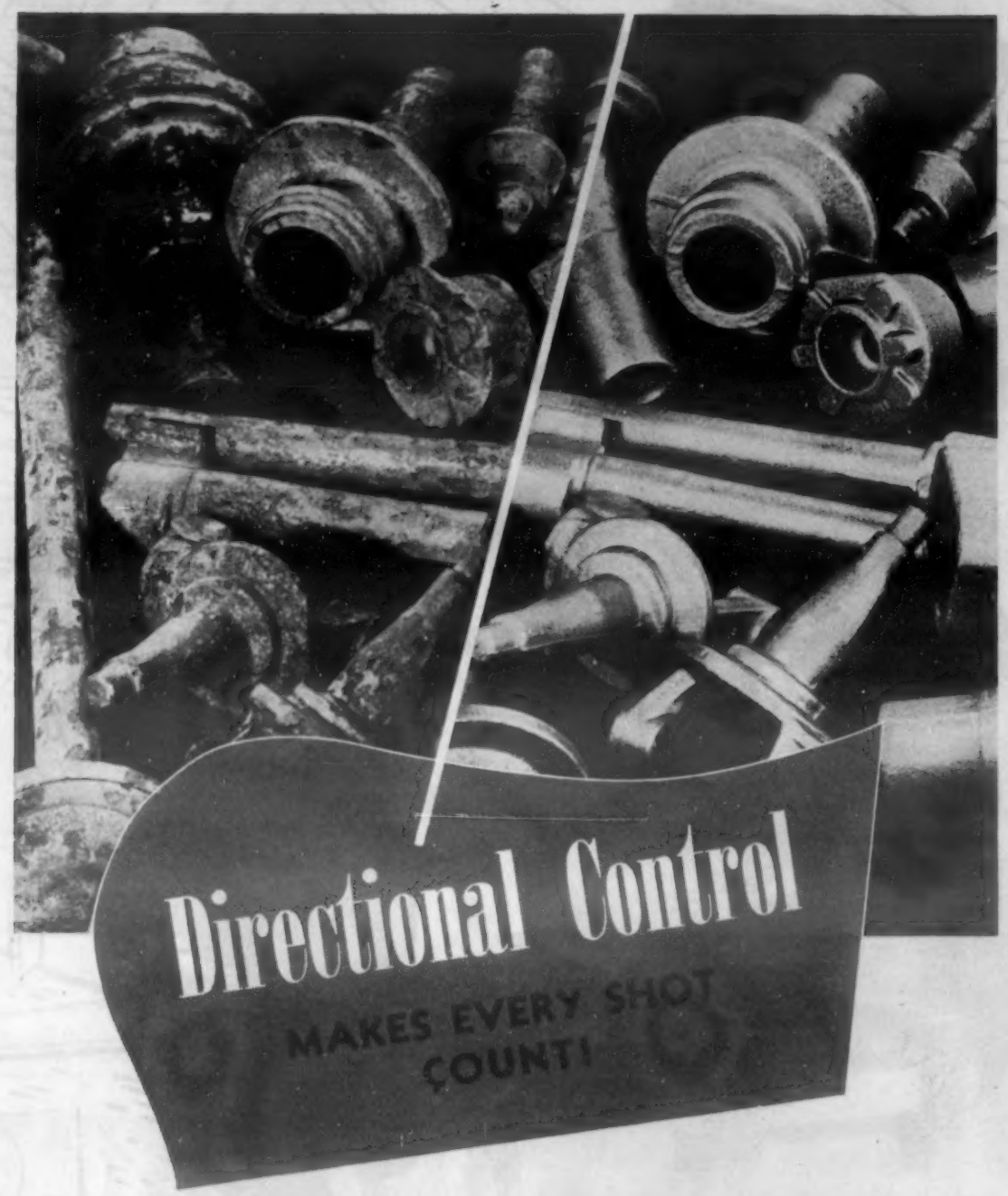
San Francisco & Los Angeles, Cal.

Buck & Hickman
London, England



280,000 shot hurled every second by the Airless Wheelabrator. You can easily visualize the cleaning power represented by that tremendous volume of individual impacts.

Speed is paramount in metal cleaning efficiency and the above unretouched photograph of automotive forgings shows a typical "before" and "after" example of how directional control made every shot count. Note the bright, scale-free finish obtained. Cleaning like this takes less than ten minutes per load on the average. Compare this with less modern methods and you will realize that "Wheelabrating" is synonymous with "Speed Cleaning".

Equally important is the fact that airless Wheelabrator abrasive blasting is the *only* practical method of obtaining the uniformity and variety of finishes so necessary today. Two exclusive Wheelabrator design features make this possible:

(1) Perfected directional control of the blast stream; and

(2) a range of blast wheel sizes to provide the velocities required for various finishes.

Many customers now demand Wheelabrated parts, because they have a better appearance, take an excellent finish, and machine more easily with less tool wear.

Write for more information today!

American
FOUNDRY EQUIPMENT CO.
509 SOUTH BYRKIT STREET • MISHAWAKA, INDIANA

● Sand, brine, coal and oil are providing the basic elements to produce silicones, which can be produced as solids or liquids in an infinite variety of forms. An important use is for high temperature insulating resins. Thus, *Westinghouse* engineers redesigned a 3 h.p. motor to provide an output of 10 h.p. by using high temperature resistant silicones for the electrical insulation. Prominent in the development of this material is the *Dow Corning Corp.*, Midland, Mich.

Center Lapper and Drill Press

A single machine that performs both center lapping and drill press operations, and costing less than many single purpose center grinders, is made by *Dalzen Tool & Mfg. Co.*, 12255 E. Eight Mile Rd., Detroit 5.

Called the Dalzen "2-in-1", one simple adjustment, needing a few seconds, changes from center grinder to drill press, and back again. One lifts a pin and swings the center grinder dresser in or out of position. It weighs 165 lb., is 67 in. high, with floor stand 15 by 21 in. The 10 by 10 in. work table is smooth and slotted for T-bolts. Standard length between centers is 39 in.

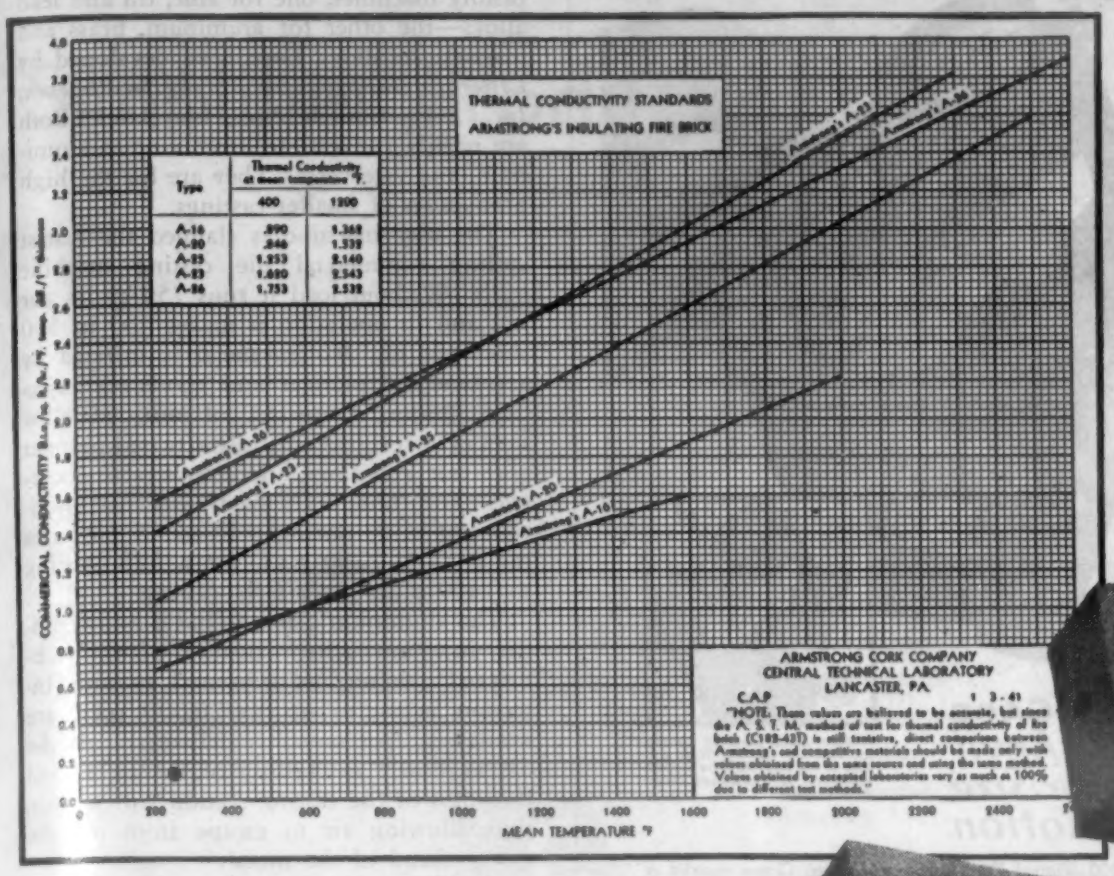
The capacity of the press, which will drill to the center of a 13-in. circle, is ½ in. The dresser is adjustable from 20 to 100°. The spindle rotates on two precision ball bearings, with a double bearing at the lower end to take thrust. It is shipped with 110 v-motor, v-belt drive, diamond and 1½ in. lapping stone.

In the accompanying photograph, it is being used as a drill press, with the dresser swung out of position.

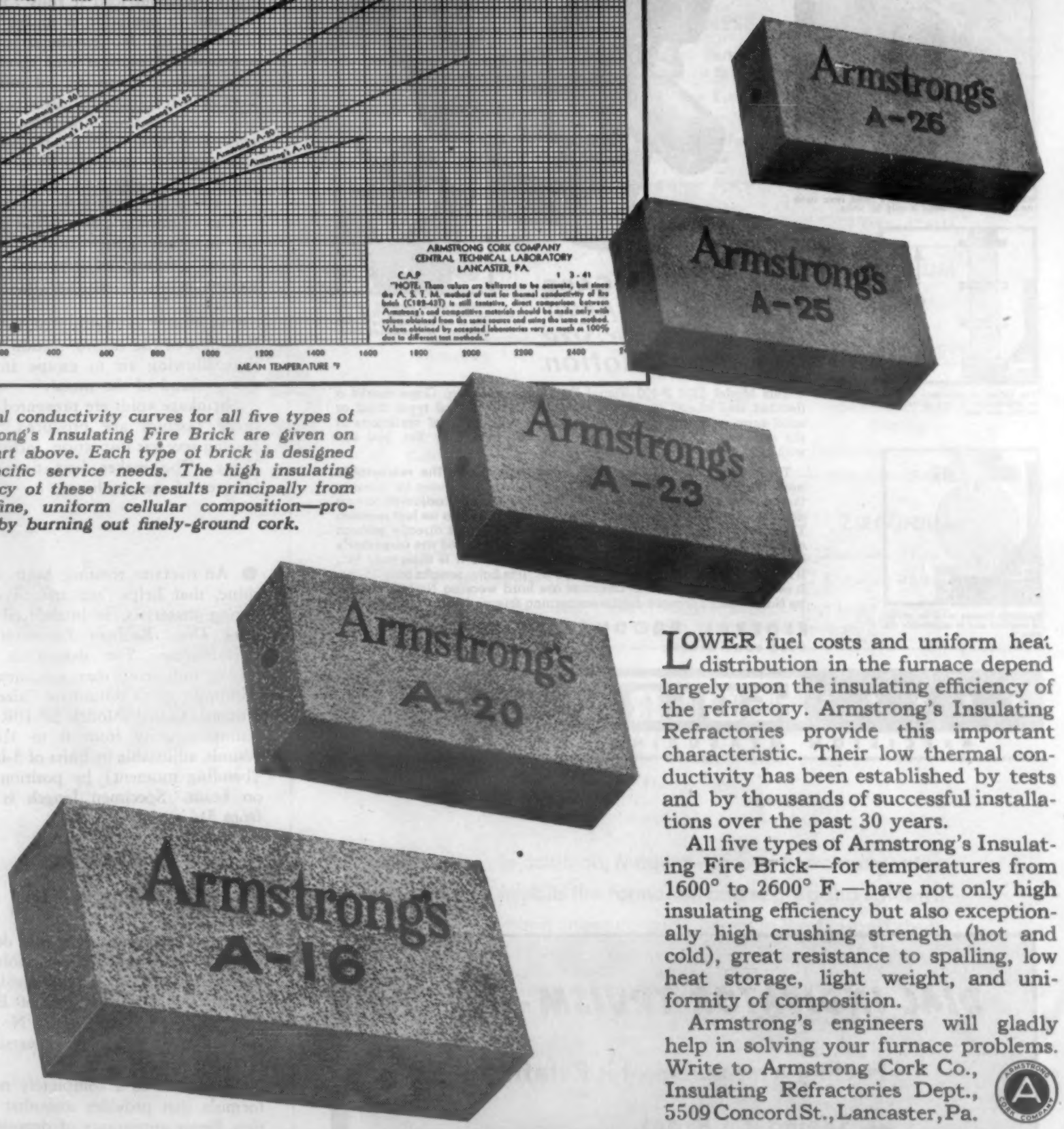
● A completely new model of the Three-Point pipe gage is announced by the *Three-Point Gage Co.*, 3821 Broadway, Chicago 13. It will measure instantaneously not only all sizes of pipe from ⅛ in. to 12 in., but all sizes of electrical conduit and metallic tubing.

HIGH INSULATING EFFICIENCY

—another reason why these brick are DEPENDABLE



Thermal conductivity curves for all five types of Armstrong's Insulating Fire Brick are given on the chart above. Each type of brick is designed for specific service needs. The high insulating efficiency of these brick results principally from their fine, uniform cellular composition—produced by burning out finely-ground cork.



LOWER fuel costs and uniform heat distribution in the furnace depend largely upon the insulating efficiency of the refractory. Armstrong's Insulating Refractories provide this important characteristic. Their low thermal conductivity has been established by tests and by thousands of successful installations over the past 30 years.

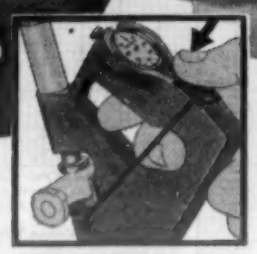
All five types of Armstrong's Insulating Fire Brick—for temperatures from 1600° to 2600° F.—have not only high insulating efficiency but also exceptionally high crushing strength (hot and cold), great resistance to spalling, low heat storage, light weight, and uniformity of composition.

Armstrong's engineers will gladly help in solving your furnace problems. Write to Armstrong Cork Co., Insulating Refractories Dept., 5509 Concord St., Lancaster, Pa.

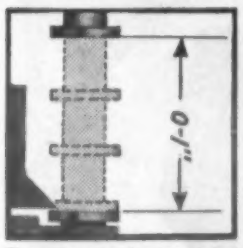
ARMSTRONG'S INSULATING REFRACTORIES

Why Not SEE Rather than feel

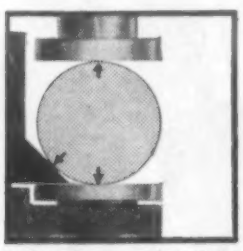
Weight of Gage and operator's hand rests upon the fixed contact. Gage is only ⅝" wide.



A *light* thumb pressure retracts the sensitive contact. Work surface is not marred. The contact movement is transferred direct to Indicator.



The upper or reference contact is adjustable to any dimension within one inch.



Backstop locates work in center of contacts and is adjustable for size.

FEDERAL

INDICATOR SNAP GAGE

with-Retractable Anvil

Adjustable for Size

No Lost Motion

This Model 1330 P-100 Visual Dial Indicator Snap Gage marks a decided step ahead in gaging practice. Conventional type, fixed or solid snap gages depend upon "feeling", and personal variations in the sense of touch influence the inspection accuracy. But, you **see** with this.

The Model 1330 P-100 has other advantages too — **The retractable anvil** makes it easier to apply, and it eliminates all excuses for marring the surface of highly finished workpieces. **It is easily adjusted** to any dimension within one inch and locked in place. **There is no lost motion.** The movement of the sensitive contact is transferred directly without error to the Dial Indicator. **The weight of the Gage and the inspector's hand rests upon the fixed or reference contact. It is thin:** only ⅝". It is small; not over 6" at the longest point. It is light; weighs only 15 ozs. It reads in tenths (.0001"). Contacts are hard wearing Norbide (Made by Norton Co.) For more details concerning this modern snap gage write

FEDERAL PRODUCTS CORPORATION

1144 EDDY STREET PROVIDENCE 1, R. I.

★ ★ ★ ★ ★ **FEDERAL** ★ ★ ★ ★ ★

PRECISION MEASURING INSTRUMENTS

DIAL INDICATOR TRUISM —

Feeling a measurement is **Relative**

— Seeing it is **Exact.**

★ **FEDERAL** ★

Two Types of Die Casting Machines

Two new high-speed, high-pressure die casting machines, one for zinc, tin and lead alloys—the other for aluminum, brass and magnesium alloys, have been developed by *Lester Engineering Co.* for *Lester-Phoenix, Inc.*, 2711 Church Ave., Cleveland. Both are readily convertible, from zinc to aluminum, and vice versa. They are for the high production of smaller castings.

The zinc machine is claimed the fastest cycling commercial die casting machine built. Without load it runs 750 cycles per hr., and in operation it makes 400 to 500 shots per hr. Molten metal is injected by a submerged plunger and gooseneck injection system, consisting of nitrided alloy steel cylinder, hydraulically actuated plunger with cast iron rings, and a removable gooseneck and nozzle of heat- and corrosion-resistant alloy castings. Injection pressures range from 2200 p.s.i. for a 4-lb. casting to 1400 p.s.i. for a 6-lb. casting.

The aluminum machine has a cold chamber injection system instead of the submerged plunger and gooseneck system. Injection pressures up to 20,000 p.s.i. are available. Hot metal is delivered into the die as slowly as chilling of the metal and thickness of the casting section will permit, thus allowing air to escape from the die cavity ahead of the metal.

Shrinkage voids are prevented and strong, dense castings are produced, capable of passing severest inspection, including 100% X-ray. The maker lists five outstanding features of the machines.

● An oversize rotating beam fatigue machine, that helps "see around corners" in testing materials, is introduced by *Southwark Div., Baldwin Locomotive Works,* Philadelphia. The design is based on studies indicating that specimens of 1 in. minimum diam. eliminate "size effect" in fatigue. Called Model SF-10R, it has a testing capacity from 0 to 10,000 inch-pounds, adjustable by units of 5-inch-pounds (bending moment) by position of weight on beam. Specimen length is adjustable from 3½ to 9½ in.

Electrode for Light Metal Welding

A new electrode, especially designed for welding light gage chrome-moly and similar steels used in aircraft welding, is announced by *Air Reduction,* 60 E. 42nd St., New York 17. Called Airco No. 90-A, the electrode is an improved version of the smaller sizes of No. 90.

It is made to a completely new coating formula that provides smoother arc operation, better appearance of deposits, stronger arc action, reduced slag interference, and excellent operation at high currents without deterioration of coating at stub end.

It is to be had in three popular sizes for light gage welding—1/6-, 5/64- and 3/32-in. diam. It is equally efficient for a.c. and d.c. operation, straight or reverse polarity. Specimens welded on SAE 4130 show transverse tensile strengths of 80,000 to 90,000 p.s.i. It meets specifications of various societies.

Medium-Carbon Ferromanganese Simplifies Production of Low-Carbon Steel

Electromet Ferro-Alloys and Metals

CHROMIUM

Low-Carbon Ferrochrome (in grades, maximum 0.06% to maximum 2.00% carbon)
High-Carbon Ferrochrome
Nitrogen-Bearing Ferrochrome
SM Ferrochrome
Chromium Metal
Chromium-Copper
CMSZ Alloy
Miscellaneous Chromium Alloys

CALCIUM

Calcium-Silicon
Calcium-Manganese-Silicon
Calcium Metal

COLUMBIUM

Ferrocolumbium

MANGANESE

Standard Ferromanganese 78 to 82%
Low-Carbon Ferromanganese
Medium-Carbon Ferromanganese
Manganese Metal
Miscellaneous Manganese Alloys

SILICO-MANGANESE

TUNGSTEN

Ferrotungsten
Tungsten Powder

BORON

Ferroboron
Manganese-Boron
Nickel-Boron
SILVAZ Alloy 3
SILCAZ Alloy 3

SILICON

Ferrosilicon 50%
Ferrosilicon 75%
Ferrosilicon 80 to 90%
Ferrosilicon 90 to 95%
Silicon Metal
SMZ Alloy
Miscellaneous Silicon Alloys

VANADIUM

All grades

EM BRIQUETS

Silicon Briquets
Silicomanganese Briquets
Ferromanganese Briquets
Chromium Briquets

ZIRCONIUM

Zirconium 12 to 15%
Zirconium 35 to 40%

"CMSZ," "Electromet," "EM," "Silcaz," "Silvaz," "SM," and "SMZ" are trade-marks of Electro Metallurgical Company

Information about Medium-Carbon Ferromanganese and the other alloys and metals produced by Electromet is contained in the booklet "Electromet Products and Service." Write for a copy.

In the production of low-carbon steel, Medium-Carbon Ferromanganese introduces less carbon to the bath than standard ferromanganese. Consequently, oxidation of the bath need not be so severe; the heat can be tapped from 15 to 30 minutes sooner; and furnace output is increased. Refractory costs and total conversion costs are lowered.

In addition, Medium-Carbon Ferromanganese inhibits the formation and segregation of hard manganese carbide areas in the finished steel.

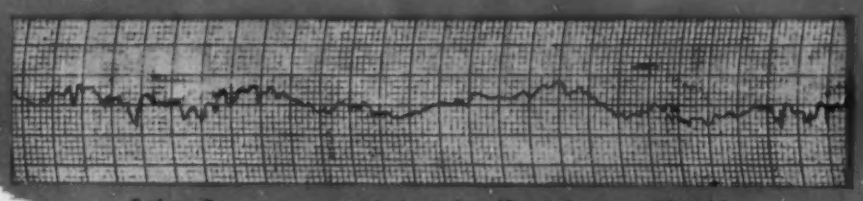
One of our metallurgists will call at your request to explain more fully how you can use Medium-Carbon Ferromanganese and other "Electromet" ferro-alloys to advantage. This service is available without obligation.

BUY UNITED STATES WAR BONDS AND STAMPS

ELECTRO METALLURGICAL COMPANY
Unit of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.
In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario

Electromet
Trade Mark
Ferro-Alloys & Metals

Proof of a Better Finish



Each small square represents 1.0 micro inches. Micro inch r.m.s. = 0.5 — 1.0.

Surface Analyzer Tape Proves You Get a Better Finish With Chicago Wheels

These results were obtained at a rate of 10 pieces per hour in an aircraft parts plant. Material, X-13-15, Rockwell 60 to 57, grinds out .006 to .007 stock. Chicago Wheel used, ½ x ½ x ⅛", Grain 180, Grade L Arcite FV Bond. Spindle Speed 40,000 r.p.m. Lapping and super finishing eliminated on this job.

Can you match that finish? Sounds phenomenal, but you can do it with Chicago Wheels. And, the secret of their superiority lies in the new FV Bond, developed exclusively for Chicago Wheels, after 50 years' experience making wheels for the most accurate and precise applications.

Here's What FV Bond Will Do for You

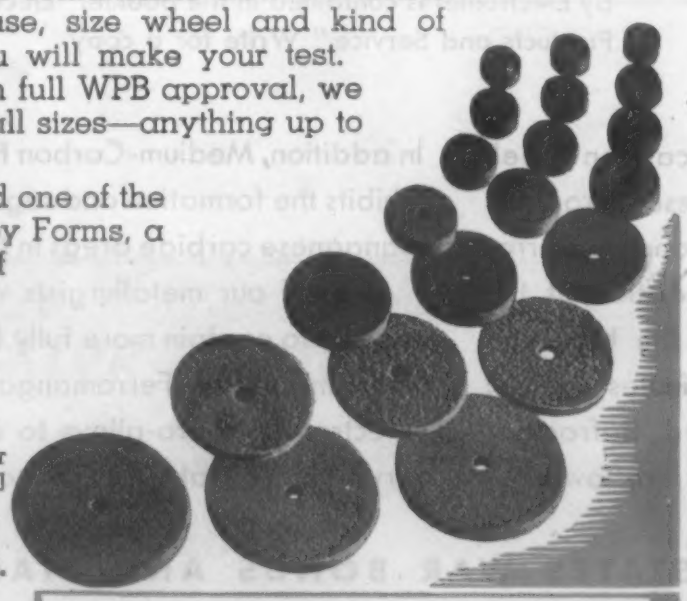
* Reduce your wheel costs
* Produce a better finish without sacrifice of production time—a finish so smooth that you can measure it in micro inches.

TRIAL WHEEL FREE

Write or send the coupon today for a Chicago Wheel, made with this remarkable new FV Bond. Tell us grinder you use, size wheel and kind of material on which you will make your test.

For the duration, with full WPB approval, we are specializing on small sizes—anything up to 3" in diameter.

Write for Catalog and one of the new Engineering Survey Forms, a step in the direction of better finishing.



CHICAGO WHEEL & MFG. CO.

America's Headquarters for Mounted Wheels and Small Grinding Wheels.

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Half a Century of Specialization has Established our Reputation as the Small Wheel People of the Industry.

ME-9

Send Catalog and Survey Form. Interested in
( ) Mounted Wheels. ( ) Grinding Wheels.
( ) Send Test Wheel. Size.....

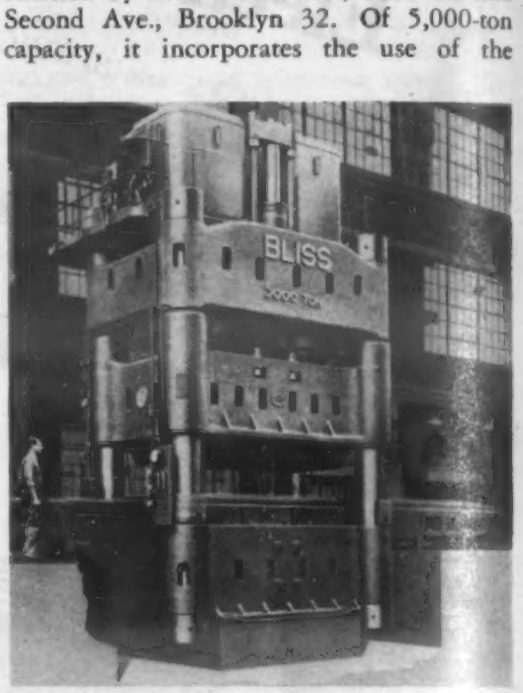
Name.....

Address.....

● A new, low cost, universal marking device for where markings must be stamped uniformly around the circumference of round holes is sponsored by *New Method Steel Stamps, Inc.*, 147 Jos. Campau, Detroit 7. It is suitable for annular marking of bushings, sleeves, gears, etc., where many parts carry identical series of numbers. A marking die is retained on a pilot holder by two set screws that fit into a groove machined into the pilot. All hammering strains are transmitted to the shoulder of the guide. It is manufactured to fit individual requirements.

One of World's Heaviest Presses

One of the largest and heaviest self-contained presses ever built is that installed in a large U. S. bomber plant and constructed by *E. W. Bliss Co.*, 53rd St. and Second Ave., Brooklyn 32. Of 5,000-ton capacity, it incorporates the use of the



rubber die process, so peculiarly adapted to the diversified production of the aircraft industry. It contains the automatic die slide that was outstandingly successful on the 4 and 6 die slide presses.

It has an automatic cycle that moves the die slide into position in 4-½ sec., the stroke being 168-1/16 in. In position, the press completes a pressing cycle with pressure independently adjustable for each die slide. After the cycle, the slide automatically moves out into its loading and unloading position as smoothly as it moved in.

● An easy-reading thread slide that saves time for engineers, draftsmen, inspectors and machinists is announced by the *S & B Engineering Co.*, 507 N. St. Clair St., Pittsburgh. It consists of a pocket and a slide of Bristol board on which is printed all specifications for screw and nut for classes 1 to 4 fine and coarse threads. As the slide is moved, a slot in the pocket exposes readings for any desired size screw. Tables on the pocket make it easy to obtain readings to fit special thread dimensions and tolerances and for special screw sizes. Thread specifications can be obtained in 1/40th the time required from tables.

Rolled Bronze BEARINGS

● Engineers and designers for the future, in search of high quality thin-wall bearings, will do well to consider Johnson ROLLED BRONZE. By virtue of the material used and our method of manufacture, we are able to provide considerable resistance to pounding and to shock with excellent bearing performance and long bearing life. Any type of oil groove, slot of hole, can be incorporated, or the bearing can be serrated for graphite or ball indented to retain grease.

Also, Johnson ROLLED BRONZE is ideal for washers, thrust plates, or a wide variety of flat pieces.

It's an easy matter to determine if this type of bearing will give you the performance you desire. Simply call in a Johnson Engineer. Make full use of our more than thirty-five years' exclusive bearing experience. As we make ALL types of Sleeve Bearings we base our judgment on facts . . . free from prejudice. Can we be of service to you?

SLEEVE TYPE BEARINGS

Cast Bronze Bearings
Cast Bronze Graphited
Sheet Bronze Bearings
Sheet Bronze Graphited
Bronze and Babbitt Bearings
Steel and Babbitt Bearings
Steel and Bronze Bearings
Ledaloyl
Self-Lubricating Bearings
Electric Motor Bearings
Automotive Bearings
Bronze Bars
Bronze Castings

Any Type
Any Size
Any Quantity

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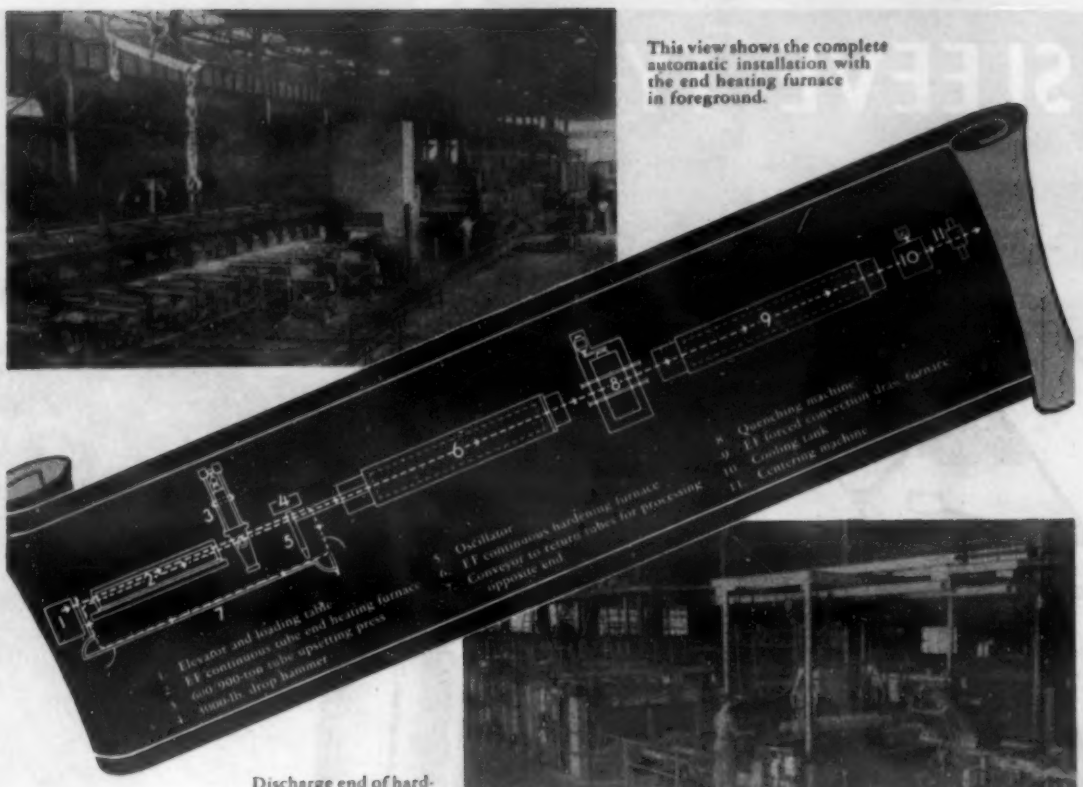
SLEEVE BEARING HEADQUARTERS
769 S. MILL STREET NEW CASTLE, PA.

The MOST COMPLETE SLEEVE BEARING SERVICE in the WORLD


1. Elevator and loading table
2. EF continuous tube end heating furnace
3. 600/900-ton tube upsetting press
4. 3000-lb. drop hammer
5. Oscillator
6. EF continuous hardening furnace
7. Conveyor to return tubes for processing opposite end
8. Quenching machine
9. EF forced convection draw furnace
10. Cooling tank
11. Centering machine

This view shows the complete automatic installation with the end heating furnace in foreground.

Discharge end of hardening furnace and charging end of draw furnace with automatic quench between.

EF Furnaces are Important Units in

Producing the New Tubular R.R. Axles

... by continuous production line methods

In the Pittsburgh Steel Company's modern plant for producing the new tubular railroad axles; the upsetting press, the drop hammer, three continuous automatic furnaces, quenches, straightener and other equipment are all tied in together, in one complete continuous straight line production unit.

EF furnaces are playing an important role in this outstanding installation. An EF continuous gas fired end heating furnace and automatically controlled EF hardening and drawing furnaces are providing the accurate heating cycles specified for producing the exact physical characteristics required by the producers of these new tubular axles.

This is just another example of how EF engineers are qualified to cooperate with industry in designing and building dependable production heat treating equipment for new and unusual applications and developments.

Submit *your* production furnace problems to EF engineers. It pays.

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces—For Any Process, Product or Production

FURNACES OIL, GAS or ELECTRIC

For Every Heating and Heat Treating Process

Aluminum Brazing	Carburizing	Nitriding
Annealing	Drawing	Normalizing
Billet Heating	Enameling	Soaking Pits
Bright Annealing	Forging	Scale-Free Hardening
Bright Hardening	Hardening	Quenching Machines
Copper Brazing	Malleablizing	Ceramic Kilns, etc.
Controlled Atmosphere	Silver Soldering	Process Heating

We Build the Furnace to Fit Your Job

THE ELECTRIC FURNACE CO.

SALEM, OHIO

Induction Heating Hardening and Quench Table

A general purpose two-station hardening and quench table, used with high-frequency induction heating generators and suitable to a wide variety of machine parts needing surface hardening or localized heating, is announced by *Induction Heating Corp.*, 389 Lafayette St., New York 3.

With quick change coil connections, so that jobs can be set up in 2 or 3 min. to change a heating coil, one need only make two coupling connections to the leads at each outlet station. It can serve as a single purpose unit, using two identical fixtures, or as a general purpose table for various kinds of hardening operations, even with lots of only 6 or 12 pieces.

An initial timer records a new job as to heating time, eliminating stop watches. After initial heating time is determined, the timer can be cut out by a selector switch. A master 3-stage timer automatically controls heating and quenching positions of the cycle, incorporating slight delays between heating and quenching when needed.

Hose connections to quench rings around the part permit spray quenches, the duration being controlled by the master timer that operates a solenoid valve. Spray quench of selected periods can be applied, so that specific control of hardness readings can be obtained, thus often eliminating the need of additional drawing or tempering operations.

Two rotary-driven spindles provide slow rotary motion, such as for hardening gears, this motion often eliminating the need for precision-made coils.

● A new ⅜ in. impact wrench that operates with controlled torque is announced by the *Aro Equipment Corp.*, Bryan, Ohio. This pneumatically powered tool completely prevents stretching or "burning" of threads, is capable of forward and reverse rotation and has a calibrated adjusting screw on the side of the motor that enables the operator to set any bolt or nut to any desired tension.

Stripper for Zinc Plate

An alkaline stripper for the rapid removal of zinc plate, called "Enthone" zinc stripper, is a new product of the *Enthone Co.*, 473 Elm St., New Haven, Conn. It removes zinc-plated coatings of all types. Thicknesses of 0.001 in. will strip in 30 sec., leaving the metal clean and bright.

Due to the alkaline nature of the solution, the tendency for rusting of the steel after stripping is largely removed, whereas this is a serious problem when acid strips are used. It is effective for removing zinc coatings that have been treated with various chromate processes and for all types of bright zinc plates.

The stripper is supplied as salts that are added to water in the concentration range of 2 to 3 lb. per gal., and the mixture heated from 200 to 215 F. Plain steel tanks and heating coils are used.

The stripper is ideal for the removal of zinc from defective plating work and from plating racks, wires and hooks, and is being used in automatic cycles for cleaning of the racks.

and . . .

STRESS RELIEVING
HEATING FOR FORGING
SPHEROIDIZING
HEAT TREATING GEARS
MELTING
BAKING PORCELAIN
BAKING CORES AND MOLDS
HEAT TREATING PARTS
HEAT TREATING TOOL STEELS

Select any industrial process involving oil or gas-fired equipment, and you will find that Spencer Turbos are prominent in that field.

Pick any one of the leading manufacturers of heat-treating equipment and you will find that Spencer Turbos have been their preference for many years.

The reasons: A simplicity of design—as simple as a fan, as sturdy as a bridge—with wide clearances and only two bearings to grease—plus automatic maintenance of pressure regardless of load.

These and many other facts are contained in the Spencer Bulletins and the Spencer Turbo Data Book—Yours for the asking.

THE SPENCER TURBINE COMPANY • HARTFORD 6, CONNECTICUT

257-C

TURBO-COMPRESSORS

TO MULTIPLY THE RANGE OF YOUR

PYROMETER INSTRUMENTS

ENGELHARD manufactures a complete range of assembled thermocouples consisting of thermo-elements with insulators, protection tubes, terminal heads, couplings and various accessories. Thermo-elements may be platinum vs. 90% platinum 10% Rhodium, Reclaiming Platinum vs. Platinum Rhodium, Chromel vs. Alumel, Iron vs. Constantan and Copper vs. Constantan.

Selection Is Important

ENGELHARD assembled Thermocouples insure maximum efficiency from their pyrometer instruments because each is made up from selected individual parts, chosen because of their ability to meet the requirements of a specific application.

Whether the atmosphere encountered is reducing, oxidizing or corrosive—the maximum temperatures likely to be encountered, probable quick changes in temperatures, how often the thermocouple will be removed or the lead wires disconnected—these are only a few of the main points in successful thermocouple selection.

Take your Thermocouple problems to Engelhard!

CHARLES ENGELHARD, INCORPORATED
90 CHESTNUT ST., NEWARK, NEW JERSEY

Free Flowing Solder for Aluminum

What is claimed to be the first free-flowing soft solder for use on aluminum and aluminum alloys is announced by *Eutectic Welding Alloys Co.*, 40 Worth St., New York 13. It is called EutecRod 199, and it supplants the alloy previously known as EutecRod 19B.

Used with "Autochemic" Eutector Flux 199, the new welding rod will flow on aluminum as readily as ordinary lead-tin solder on tin plate, brass or copper. Sheet aluminum can now be lock-seamed, or lapped and spotwelded or riveted, and the joint sealed with the new solder.

In long laps it will make joints of moderate strength, but it should generally be used as a seal. It will work on cast and wrought aluminum and on steel, copper and nickel alloys. It is suitable where the completed joint will not be heated over the boiling point of water (212 F.) under working conditions.

Applied at 400 F., thin sheet metal is joined without distortion. It will bond to cast iron, if the latter is "tinned" with a zinc base solder.

City gas and air, propane and air, acetylene and air, and other torches of this type are best to use with "199," being low heat flames. It is available in ⅛-in. rod in packages ranging down from 200 to 25 lb.

News of Engineers

William J. Priestley has been elected president of Electro Metallurgical Co., and three other units of Union Carbide and Carbon Corp., succeeding the late *Francis P. Gormely*. Throughout his business career Mr. Priestley has been a leader in extending the uses of stainless and alloy steels. In 1923 he became consulting metallurgist for Electro Metallurgical Co. At several times he has been in government service during both world wars. In his early days he was with Bethlehem Steel Corp.

H. O. Teeple, chemical engineer, has joined the Technical Service Group, Development and Research Div., International Nickel Co., Inc., at New York, specializing in corrosion problems. He has had experience in production, process control and maintenance engineering.

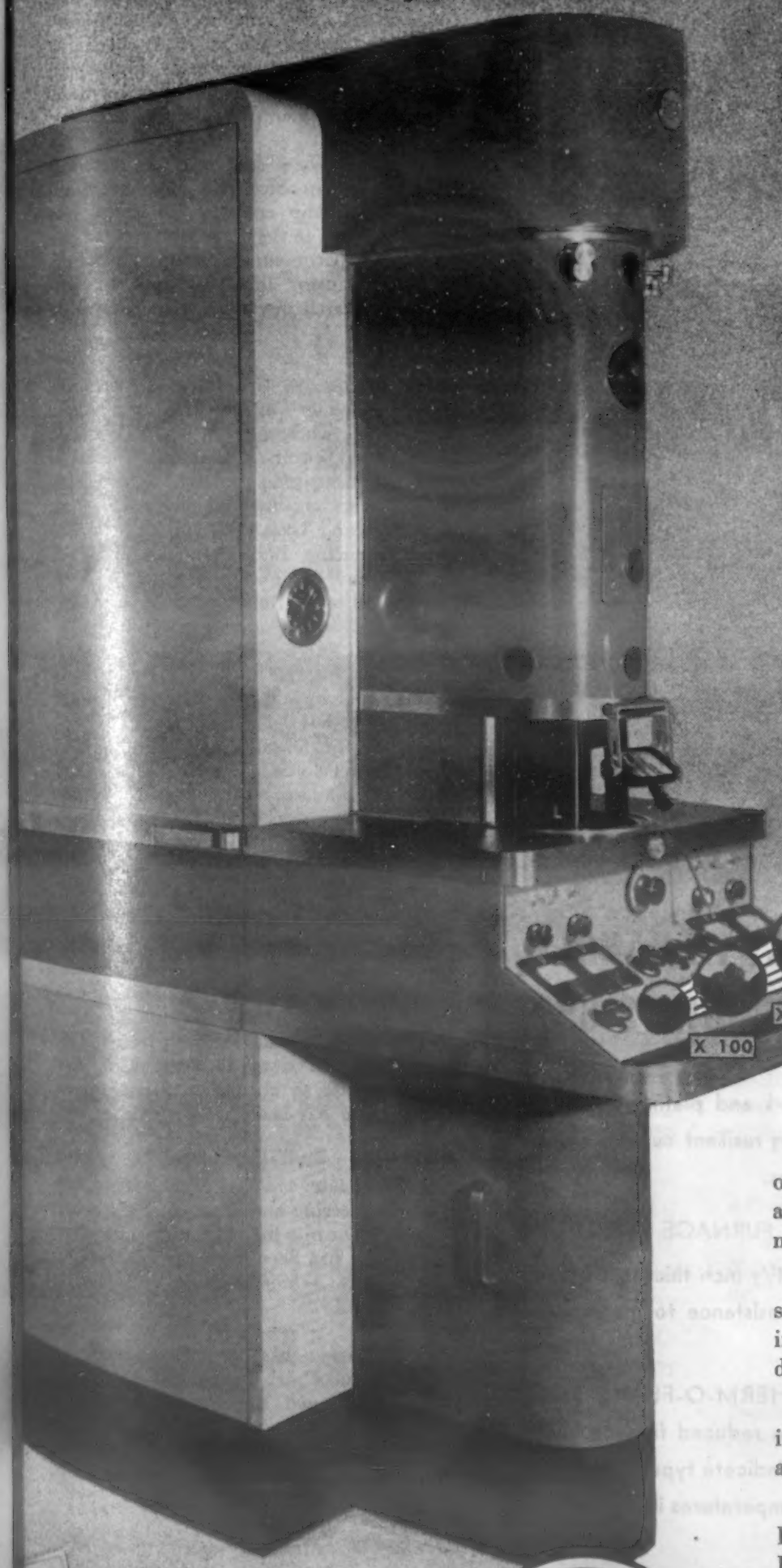
Thomas J. Wood has been made supervisor of arc welding of the American Welding & Mfg. Co., Warren, Ohio. During his 20 years' welding experience he has worked with all types of welding with alloys, stainless steel, brass, copper, etc. For two years he was welding foreman at the Mansfield plant of Westinghouse.

Edward J. P. Fisher has been made manager of sales for the Morrison Engineering Corp., Cleveland. He is widely known in the wire industry, both as first recipient of the Wire Assn. annual medal of award in 1934, and for his installation and initial operation of the first steel wire

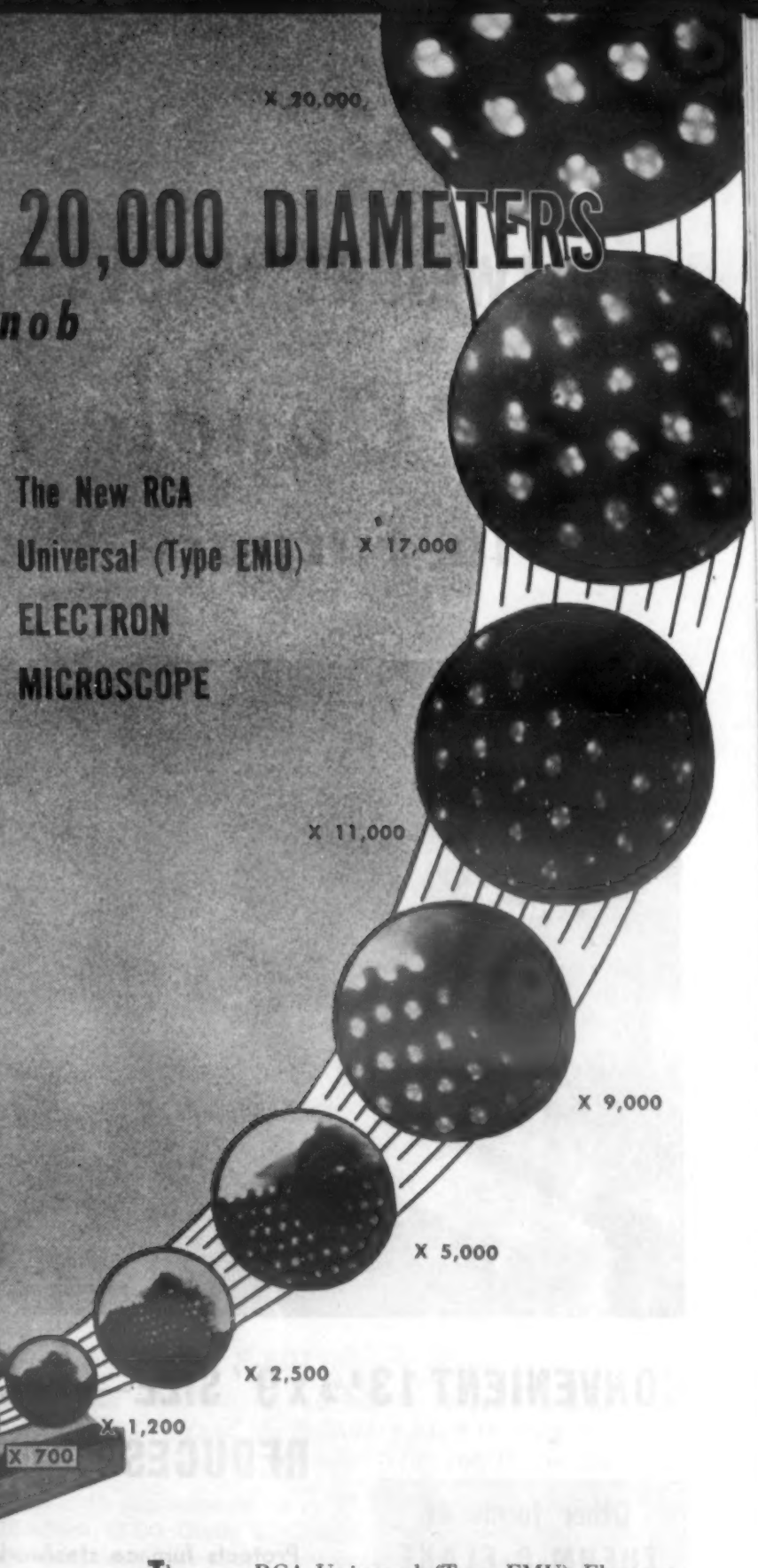
(*Continued on page 782*)

MAGNIFICATIONS of 100 to 20,000 DIAMETERS

by a twist of a knob



The New RCA Universal (Type EMU) ELECTRON MICROSCOPE



The new RCA Universal (Type EMU) Electron Microscope is designed to provide (1) maximum operator comfort and convenience, (2) maximum simplicity and flexibility, (3) consistent top performance, and (4) maximum ease of servicing.

The operator of this microscope, by merely turning a single knob, can enlarge the clear, sharp image he is observing through 40 steps of magnification ranging from 100 diameters up to 20,000 diameters.

This is but one example of the ease with which this instrument can be used in practice. Making micrographs at any magnification is equally simple.

Detailed descriptions of the new RCA Universal (Type EMU), and the new RCA Console (Desk Model, Type EMC) Electron Microscopes are contained in the booklet shown at the left. Copy of this booklet will be sent promptly on request.

The new RCA Type EMU Universal Model RCA Electron Microscope, also the new RCA Type EMC-1 Console (Desk Model) Electron Microscope, are described and illustrated in this new RCA Bulletin. Copy sent promptly on request.

RCA

RADIO CORPORATION OF AMERICA

RCA VICTOR DIVISION • CAMDEN, N. J.

LEADS THE WAY . . *In Radio . . Television . . Tubes . . Phonographs . . Records . . Electronics*

This

LIGHTWEIGHT INSULATING BRICK

does "Double Duty"

in Furnace Walls

CONVENIENT 13½ x 9" SIZE—EASY TO HANDLE

REDUCES WALL JOINTS 65%

Other forms of THERM-O-FLAKE INSULATION

Coating — Seals and Insulates all types of furnace walls. Highly plastic, works and spreads easily.

Blocks — Highly efficient insulation where larger size units may be required.

Concrete — Monolithic castable insulation with high insulating value.

Granules — Loose-fill, efficient insulation, weighs only 6 pounds per cubic foot.

Protects furnace steelwork and plating from excessive heat with a strong resilient cushion which absorbs expansion stresses.

KEEPS HEAT INSIDE FURNACE WALLS

Excellent insulation,— a 4½ inch thickness being equivalent in heat flow resistance to more than 29 inches of fire brick.

Find out how quickly THERM-O-FLAKE Brick will pay back their cost in reduced furnace heat losses. For specific data, indicate type of furnace and approx. operating temperatures in writing to:

Illinois Clay Products Company
JOLIET, ILLINOIS

Therm-O-flake BRICK

FOR HOT FACE TEMPERATURES UP TO 2000° F.

mill on the island of Newfoundland, as consultant for the United Nail and Foundry Co., Ltd. at St. Johns.

Arthur J. Miller has been elected president of the Chicago Wheel & Mfg. Co., producer of mounted wheels, grinding wheels and allied abrasive products. He succeeds his father, the late *Henry E. Miller,* who founded the company in 1894. He developed mounted wheels, high speed electric grinders and several processes widely used throughout the abrasive industry.

Samuel D. Lemmon, research metallurgist for Lukens Steel Co., has been appointed assistant engineer of tests. He joined Lukens in 1939 as observer in the research department, became a metallurgical investigator in 1940 and was appointed research metallurgist in November 1943.

Dr. Walter M. Mitchell has been appointed director of research for Mack Trucks, Inc., where he will direct chemical, metallurgical, electrical, mechanical, Diesel, fuels, lubricants, etc. projects. Before joining Mack he was chief metallurgist for the York Safe and Lock Co.'s special ordnance plant producing Bofors anti-aircraft guns for the Navy. He has also served with Carnegie-Illinois, Republic Steel and du-Pont companies.

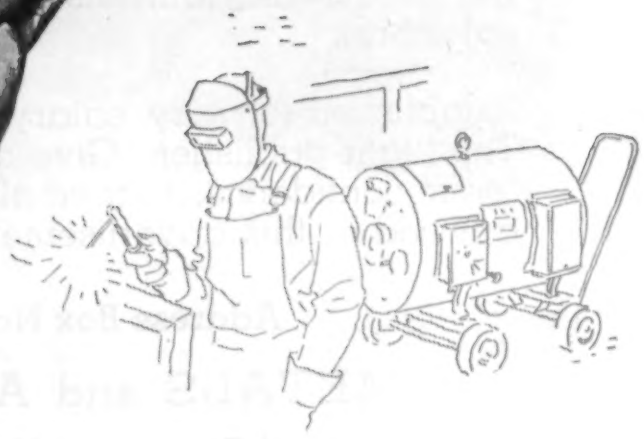
Jesse J. Baum, until recently process engineer and metallurgist with the Allison Engineering Div., General Motors Corp., has joined the Duraloy Co., Scottdale, Pa. as plant superintendent. He has been in metallurgical and supervisory capacities with National Alloy Steel Co., Ohio Steel Foundry Co., Universal Cyclops Corp., and Ingersoll Steel & Disc Div., Borg Warner Corp.

Eugene M. Smith, metallurgist, has joined Battelle Institute, Columbus, to do research in non-ferrous metallurgy, having formerly been with the Aluminum Co. of America. *Dr. L. W. Eastwood,* formerly vice president, Maryland Sanitary Mfg. Co., has joined Battelle to engage in metallurgical research. He has been author, teacher and industrialist.

James R. Longwell has been made director of engineering and research at Carboloy Co., Inc. During his 15 years with that company he has been successively development engineer, chief engineer and factory manager.

R. T. Muench has been made manager, X-ray products department of Westinghouse. He joined the Pittsburgh X-Ray div., Westinghouse, in 1935 after having served with the United States Engineers, the Dick X-Ray Co., the Engeln X-Ray Co. and Bauer & Black.

Elmer W. Pfeil has been made vice president and general manager, Anker-Holth Mfg. Co., Port Huron, Mich. He was formerly with Republic Steel Corp. as manager of the salvage and reclamation department and manager of the expediting department. In earlier years he was with Bourne & Fuller Co.



Both AC and DC WELDING with the *Same* ELECTRODE!

Here they are . . . two new P&H electrodes — which perform equally well on either AC or DC!

Thoroughly proved in a wide variety of work, these remarkable new electrodes deliver an arc that is extremely stable, easily controlled and produces fine, uniformly strong welds.

You've waited for this . . . to simplify your welding problems — to make your electrode buying easier . . . to save time and money. Convince yourself—on your own welding jobs — that they are a practical answer to better welding at lower costs.

Place a trial order *today!*

AC-1 (E-6010 and E-6011)

For AC, and either polarity on DC. • Tensile strength, 65,000-70,000 P.S.I. • Yield, 55,000-60,000 P.S.I. • Ductility, (2"), 25% to 35%. • Available in all sizes — 14" and 18" lengths.

Conforms to requirements of: U. S. Navy Bureau of Ships specifications 46-E-3 Grade 3, Class 1, 2 and 3. • Hartford Steam Boiler and Insurance Company. • American Bureau of Shipping. • Lloyds Register of Shipping.

AC-3 (E-6012 and E-6013)

For AC, and either polarity on DC. • Tensile strength, 65,000-70,000 P.S.I. • Yield, 55,000-60,000 P.S.I. • Ductility, (2") — 18% to 25%. • Available in all sizes — 14" and 18" lengths.

Conforms to requirements of: Hartford Steam Boiler and Insurance Company. • American Bureau of Shipping. • Lloyds Register of Shipping. • *Full information and procedures on request.*

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HARNISCHFEGER CORPORATION
WELDING ELECTRODES • MOTORS • HOISTS P&H ELECTRIC CRANES • ARC WELDERS • EXCAVATORS

Canadian Distribution: The Canadian Fairbanks-Morse Co., Ltd.

Life-Time Opportunity

For a competent salesman — not over 40 years of age — with background in the industrial or engineering field. Must be familiar with metal-working operations and alloy materials.

Here is a chance to represent one of the leading engineering journals as advertising space salesman.

Established territory, salary and commission. Top-flight publisher. Give details in first letter, in confidence. Our employees have been advised of this advertisement.

Address Box No. 88

METALS and ALLOYS

330 West 42nd Street New York 18, N. Y.

NOTE

"Proper Melting Decreases Foundry Losses," contains interesting data. Also, the booklet, "Nonferrous Ingot Metals of Today." Write for both of these. They are free.

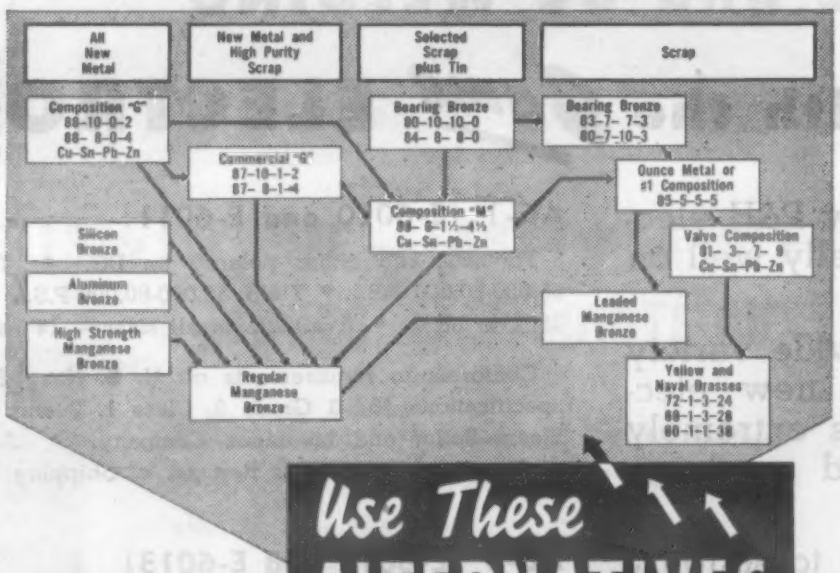
●

Send for booklet
"INGOT METALS OF TODAY"

●

16 STANDARD INGOT METALS BY AJAX

Ajax Tombasil
Ajax Plastic Bronze
Ajax Anti-Acid Bronze
Ajax Phosphor Bronze
Ajax Red Brass Ingots
Ajax Manganese Bronze
Ajax High-Tensile Manganese Bronze
Ajax Golden Glow Yellow Brass
Ajax-Hamilton Gear Bronze
Ajax Nickel-Copper 50-50%
Ajax Manganese Copper
Ajax Aluminum Alloys
Ajax Phosphor Copper
Ajax Silicon Copper
Ajax Nickel Alloys
Ajax Phosphor Tin


All New Metal
New Metal and High Purity Scrap
Selected Scrap plus Tin
Scrap
Composition "G" 88-10-0-2 88- 8-0-4 Cu-Sn-Pb-Zn
Bearing Bronze 90-10-10-0 84- 8- 8-0
Bearing Bronze 83-7- 7-3 80-7-10-3
Commercial "G" 87-10-1-2 87- 8-1-4
Ounce Metal or #1 Composition 85-5-5-5
Composition "M" 88- 8-1½-4½ Cu-Sn-Pb-Zn
Valve Composition 81- 3- 7- 9 Cu-Sn-Pb-Zn
Silicon Bronze
Aluminum Bronze
High Strength Manganese Bronze
Leaded Manganese Bronze
Regular Manganese Bronze
Yellow and Naval Brasses 72-1-3-24 68-1-3-28 60-1-1-38

Use These
ALTERNATIVES
Wherever You Can

Notice how the arrows on the W.P.B. chart point to the *right*. . . . They show how alternative materials *currently available* can be utilized by foundrymen as now permitted by many designers. The purpose is to conserve primary metal at the mine through increased use of secondary ingots. Sometimes great ingenuity is called for, yet remember this:

The first program for scientific control of ingot metal was set up by Ajax 46 years ago. The result has been metal and practical technical follow-through in which Ajax increases your production by reducing rejects.

THE **AJAX METAL COMPANY**
ESTABLISHED 1880 **PHILADELPHIA**

ASSOCIATE COMPANIES:
AJAX ELECTRIC FURNACE CORP. Ajax-Wyatt Induction Furnaces for Melting
AJAX ELECTROTHERMIC CORP. Ajax-Northrup High Frequency Induction Furnaces
AJAX ELECTRIC CO., INC. The Ajax-Hultgren Electric Salt Bath Furnace
AJAX ENGINEERING CORP. Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces

Dr. I. A. Oehler has become chief process engineer, American Welding & Mfg. Co., Warren, Ohio. At one time he was open hearth metallurgist of the Buffalo district, Republic Steel Corp.

Plants and Slants

Deaf and dumb workers in the Louisville Ordnance Div., *Westinghouse*, wear bright red caps as a distinctive marking so that cranemen and operators of industrial trucks will pay particular heed to such men from standpoint of safety. The caps chosen were of the type used by members of softball teams. The usual warning to clear from under crane loads is by crane bell and, in some instances, by hookmen. The management first ascertained whether the deaf and dumb employees would resent wearing such distinguishing insignia. They cooperated heartily.

A concern which has been making the same line of products for 121 years was recently awarded the Army-Navy E. This is the *Norton Pike Co.*, Littleton, N. H., (Div. of *Norton Co.*), a company that has been making oilstones and other abrasive specialties since 1823—then under the old Pike name. Two units of the Norton company have by now received this award.

Orvar Nils Ericson, a toolmaker for 22 years at the Bridgeport plant, *General Electric Co.*, was recently awarded $2000 for his suggestion which speeded the final production of the new remote fire control system of the B-29 Superfortress. The sum awarded Ericson may be the largest single amount ever given under the nationwide suggestion award system. At least it is the largest ever given by G. E.

The name of *Alpha Metal & Rolling Mills* has been changed to *Alpha Metal, Inc.*, whose address is 363 Hudson Ave., Brooklyn 1.

The industrial furnace business of the *Monarch Engineering & Mfg. Co.*, Baltimore, has been bought by the *Fisher Furnace Co.*, Chicago. Fisher acquires all rights to manufacture Monarch equipment and includes all patterns, drawings and parts inventories.

Rheem Mfg. Co. has acquired the *Atlas Steel Barrel Div., Bethlehem Steel Co.* of Bayonne, N. J. This brings the total of Rheem plants to 14, located in nine states.

The corporate name of *Wyckoff Drawn Steel Co.*, Pittsburgh, has been changed to *Wyckoff Steel Co.*

Wickwire Spencer Steel Co. has bought the business and assets of the *Sirian Wire and Contact Co.*, Newark, N. J., maker of fine drawn tungsten and molybdenum wire and rods used in the radio, electronic, electrical instrument and lamp industries.

TIME PROVEN

ACID- AND ALKALI-PROOF TANK LININGS

OF SYNTHETIC RUBBER AND RESIN

BY ATLAS-MERTZTOWN

1 – NEOBON lined tanks handling hydrofluoric and phosphoric acids at high temperatures.

ATLAS Tank Linings of ZEROK Synthetic Resin and Neobon or Rewbon Rubber....in service since 1939 and earlier in varied industries have proved their efficiency. Units in which they have been incorporated include:

CHEMICAL EQUIPMENT • SATURATORS • PICKLING TANKS TOWERS • PLATING TANKS • FUME DUCTS • FANS

ZEROK SYNTHETIC RESIN LININGS are inert to all chemicals which rubber will resist. In addition they will handle highly oxidizing acids such as nitric and chromic.

NEOBON SEAMLESS SYNTHETIC RUBBER LININGS give service comparable to that of linings of natural rubber. NEOBON Linings are easily applied in field or shop.

REWBON SEAMLESS NATURAL RUBBER LININGS are not available at present.

BRICK PROTECTION—In handling hot acids, brick linings add years of life to any type rubber or resin linings. ATLAS produces five different acid- and alkali-proof cements and a satisfactory brick lining is available to meet any combination of corrosives.

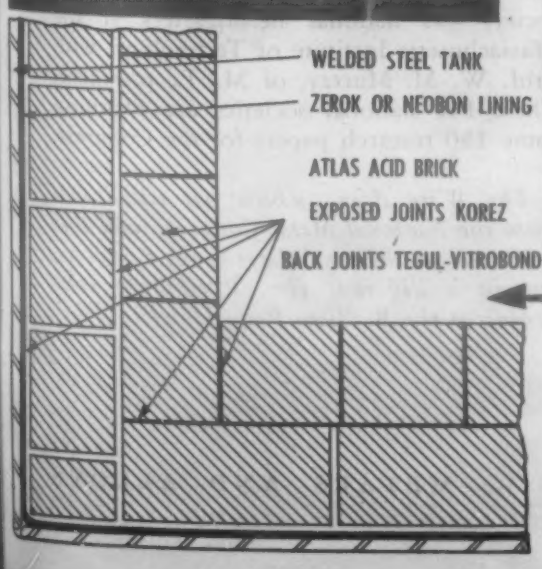
ATLAS SERVICE is complete. It includes materials of construction, design and, if desired, supervision of installation. This completely rounded service makes it possible to centralize responsibility. Small tank units like the Zerok-lined tank pictured, are built at our plant and shipped complete.

ATLAS REPRESENTATIVES able to advise on your acid-proofing problems, are located within easy reach of most industrial centers. Write the office nearest you. For Technical Bulletin TV-11A, address our head office here at Mertztown.

2 – ZEROK lined tank handling nitric and hydrofluoric acids for pickling stainless steel. In service since November 1933.

3 – 40′ tank; ATLAS Dual Construction. Lined with NEOBON or ZEROK. Handles hot sulphuric acid for pickling steel.

4 – Cross Section showing construction.



THE ATLAS MINERAL PRODUCTS COMPANY

of Mertztown Penna. Pennsylvania

*ATLANTA 3, Ga., 610 Red Rock Bldg.
*CHICAGO 1, Ill., 333 No. Michigan Ave.
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*DETROIT 2, Mich., 2970 W. Grand Blvd.
*JACKSONVILLE 5, Fla., 1463 Talbot Ave.
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*DENVER 2, Col. 1921 Blake St.
*HONOLULU 2, Hawaii, U. S. A.
*LOS ANGELES 12, Cal., 817 Yale St.
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*Stocks carried at these points

ARMY E NAVY

MOORE RAPID *Lectromelt* FURNACES

This size MT, top charge type Lectromelt furnace, operating in a Pacific Northwest mill, is pouring in excess of 5000 tons of forging ingots per month. It is one of more than 700 Lectromelts in operation daily.

PITTSBURGH LECTROMELT FURNACE CORPORATION
PITTSBURGH, PENNSYLVANIA

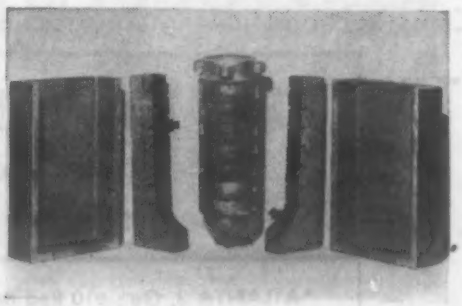
Pour Babbitt *Safely!*

Babbitrite, the proven, time-tested babbitt retainer, eliminates costly, time-consuming blowouts, prevents injury from hot molten metal. Has strength of body to hold charge; sticks to the mold. Moisture-proof and moisture free, not affected by heat, will not harden. Comes ready-for-use, requires no mixing; can be re-used over 100 times.

Liberal sample on request.

Cast Light Alloys Economically!

Illustration at right shows how Babbitrite is used as filler in parting strips in casting inexpensive chuck-jaws, of low melting point alloys, to hold irregular shaped castings for machining. Write for particulars.



Arrows show Babbitrite used to fill and seal parting strips in casting intricate, light-metal chuck-jaws.

Babbitrite THE BABBITT RETAINER

PRODUCTS MFG. CO.
521 E. Buffalo St., Milwaukee 2, Wis.

Babcock & Wilcox Tube Co. is celebrating the 25th anniversary of the laboratory at Beaver Falls, Pa., which has seen the growth from a one-room shanty, manned by three persons, to a $300,000 fully equipped modern building, manned by over 70. As a result of research activities the company produced in commercial quantities the first stainless steel tubing in the United States in August 1922.

The removal of a building from New Castle, Del., to Central Pennsylvania to serve as an addition to the plants of the *Titan Metal Mfg. Co.*, Bellefonte, Pa., has been announced. The addition is part of a $1,500,000 expansion program. The project, financed by the *Defense Plant Corp.*, includes the building and equipping of a new melting, extruding and cold-finishing brass mill. The addition, part of the Army's new program to accelerate production in heavy artillery and big gun ammunition, is expected to double Titan's production of brass rods. Between 100 and 200 additional employees will be added.

Rheem Research Products, Inc., Baltimore, has acquired a West Coast research and manufacturing branch at 714 W. Olympic Blvd., Los Angeles 15. It has also appointed three new distributors. The chief product is "Iridite," a treatment in several colors, for corrosion-proofing zinc and cadmium surfaces.

Wall-Colmonoy Corp., Detroit, maker of hard-facing alloys and overlay metals, has formed the Machine Tool Welding Div., 19351 John R. St., Detroit 5. The new division will handle all the corporation's custom and contract welding.

The *Kinney Aluminum Co.* has completed construction of its new plant at Slanson and Boyle Aves. in Huntington Park, Calif. The new plant is on the site of the former *Hercules Iron Works*. In the new plant will be the testing, chemical and X-ray laboratories. The company produces heat-treated aluminum and magnesium alloy sand and permanent mold castings.

Briefs on Associations, Promotions and Education

Two additional technical societies will participate in the forthcoming National Metal Congress at Cleveland the week of Oct. 16, but one society has dropped out, making a net gain of one. The new ones are: Society for Experimental Stress Analysis and the American Industrial Radium and X-ray Society. The Stress Analysis society has national headquarters at the Massachusetts Institute of Technology, with Prof. W. M. Murray, of M.I.T., president. These five national societies are planning some 150 research papers for the Congress.

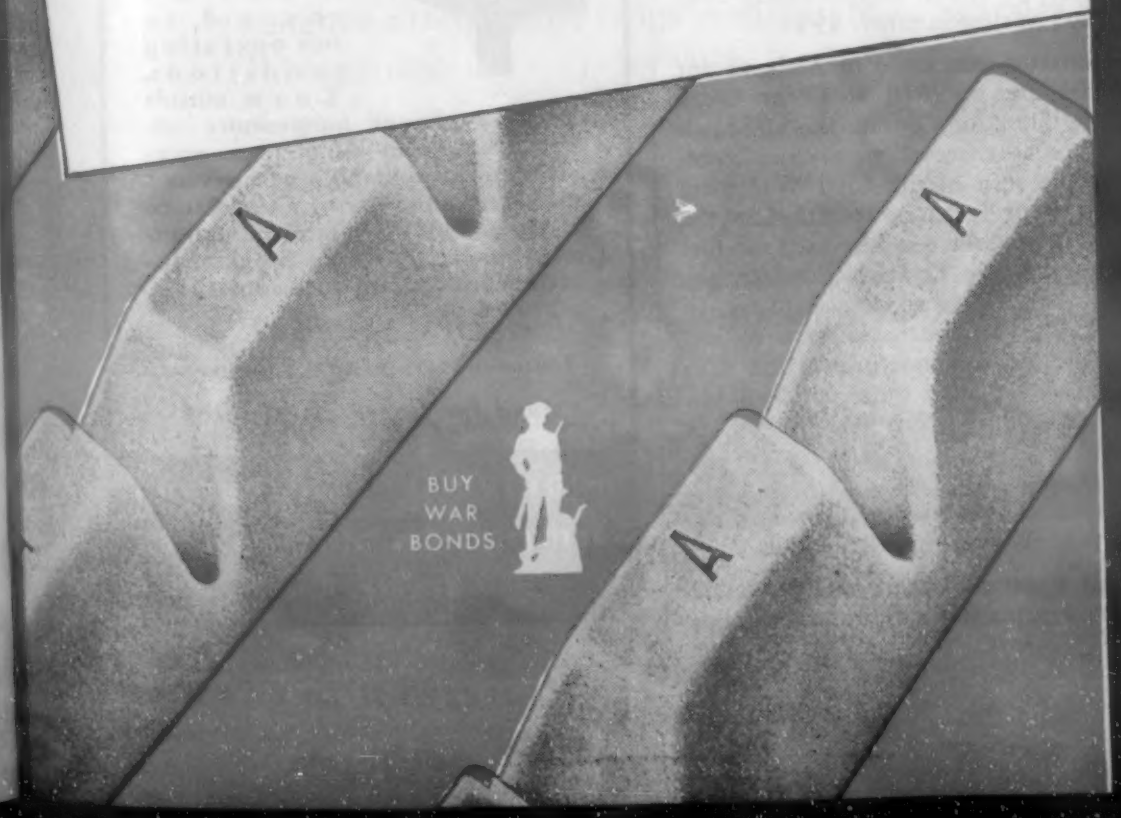
The Wire Assn., which has withdrawn from the National Metal Congress, will this year meet on the same dates as the Congress, but in a different city, Pittsburgh, convening at the William Penn Hotel.

Millions of Pounds of Aluminum... for New Ideas!

When the guns have ceased to roar and we return again to peace-time pursuits, aluminum is going to occupy an important place in the family of metals.

Its tremendous advantages, proven in war-time products, will be used to the full in many of the new ideas, that now await but the release of materials to burst into full bloom.

The vast resources of Aluminum Refiners will be available to supply the accurate analysis ingot that will be required. Perhaps we can serve you now in your war-time requirements. We would be glad to consult with you.



ALUMINUM REFINERS

Division of BOHN ALUMINUM AN
BRASS CORPORATION, Detroit 26, Michig
General Offices Lafayette Bldg.

MANUFACTURERS OF ALL TYPES AND SHAPE
OF CASTING AND DEOXIDIZING ALLOYS

Toss that EXTRA TOUGH DIE PROBLEM In OUR lap

Using Strenes Metal, we'll cast your dies to shape, (usually to 1/16") and save you around 50% to 75% on machinery time. What's more you'll put to work a die that will stand up—draw and form far more stampings than you probably believe possible. Deep draw runs of 1,000,000 and more parts a matter of record.

You'll be using a die that will require redressing far less frequently than dies of ordinary metal. Sounds good, but, hard to believe, you say! Perhaps. But our suggestion stands "Toss us that tough one" and pay for it when Strenes makes good as claimed—otherwise there will be no charge.

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100 Parnell St., Dayton 3, O.

Refrigerators
Stoves
★ Automobiles
★ Trucks
★ Tractors
Metallic Vaults
Metallic Caskets
Farm Equipment
Fans, Blowers
Bicycles, etc.
★ In automotive field in general use for drawing and forming car bodies, hoods, fenders, head lights, radiator shells.

Strenes METAL DRAWING AND FORMING DIES

At the annual meeting of the Malleable Founders' Society at Hot Springs, Va. the by-laws were modified to provide an additional office, executive vice president. Chosen to that office is Haldwell S. Colby, who has recently served on the WPB in connection with the foundry and forge program. Mr. Colby was formerly with Baldwin Locomotive Works at Eddystone, Pa.

To drive home the vital importance of castings for heavy duty trucks, jeeps and other Army rolling stock, flying caravans of Army and Navy war heroes have been touring centers of the foundry industry. In the caravan there are prominent displays, showing the importance of castings in war equipment.

The American Institute of Electrical Engineers has elected as president Charles A. Powel, manager, Headquarters Engineering, Westinghouse, for the year beginning August 1, 1944. Mr. Powel is known as a diagnostician of power plant problems.

A new two-part, all-color sound movie, "The Story of A. C. Welding," is announced by General Electric Co., Schenectady. This 16 mm. movie runs 35 min.

House Organ Notes

Electromet Review, Electro Metallurgical Co., July 1944.

The frame structure of the first airplane ever fabricated of stainless steel, "The Pioneer," has stood on exhibition for the last eight years on Benjamin Franklin Parkway, Philadelphia. Built in 1931 by Edward G. Budd Mfg. Co., it is still in perfect structural condition. The metal shows no ill effects of its long exposure to dust and other atmospheric conditions. In recent years aircraft designers have been specifying stainless steel for wing sections, control surfaces, tail assemblies and fuel tanks; as well as for such parts as exhaust lines and fire walls.

Pig Iron Rough Notes, Sloss-Sheffield Steel & Iron Co., Spring-Summer, 1944.

Pig iron was first made in Alabama for commercial use in 1818 at Cedar Creek furnace in Franklin County. Local brown ores and cedar charcoal were chief materials. At the start of the Civil War there were nine blast furnaces operating in the South. In 1876 coke was first used for fuel in Alabama at the Oxmoor furnaces, the real beginning of the iron industry in Alabama. The first furnaces were of rectangular or square stone construction with open tops and usually built beside a hill to facilitate dumping ore and charcoal in the top.

The Aluminator, Aluminum Co. of America, Lafayette Works, July 21, 1944.

At least eight aircraft manufacturers are using a new super-strength aluminum alloy

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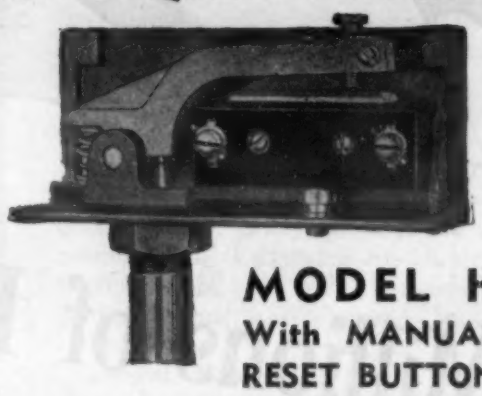

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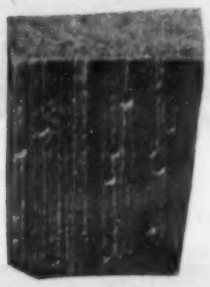

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Copper Commando, Anaconda Copper Mining Co., July 21, 1944.

By working over old dumps around Butte and Anaconda, Mont., 75,000,000 lb. of copper have been recovered that would otherwise have gone to waste. To recover these slimes, or "cats and dogs," Anaconda built a $400,000 plant. The slimes at Anaconda can be handled in winter and summer; those at Butte, only in warm weather. A large part of these dump piles were accumulated years ago when American copper ore was richer and Americans were more extravagant and wasteful with resources than today.

Pop-Offs, Chicago Malleable Castings Co., July 1944.

Here is a "Brain Quiz." Play fair, readers—don't look below the 3 em dash at the answers until you have made an honest try at the questions:

(1) Solder is an alloy of what? (2) Does a gallon of water contain 173, 231 or 268 cu. in.? (3) What is the plural of cannon? (4) What state has the smallest population? (5) How long is a fortnight? (6) Of what prison was Lewis E. Lawes warden? (7) Whose picture is on a one-dollar bill? (8) Square root of .04? (9) How many wings do bees have? (10) In the U. S. what is a tycoon?

---

(1) Lead and tin. (2) 231. (3) Cannon. (4) Nevada (91,000). (5) Two weeks. (6) Sing Sing. (7) Washington's. (8) .2 (9) Four. (10) An industrial magnate.

Steel Horizons, Allegheny Ludlum Steel Corp., Vol. 6, No. 3.

Under the heading of "New Shapes on the Horizon," we learn: "The diesel engine has developed greatly under war stress, especially for the powering of ships. Chief limiting factor heretofore has been its size and weight, largely confining its use to big units—as in ships, locomotives and power plants. The Chrysler Corp. is experimenting with diesels weighing only 11 oz. per h.p., which can operate on gasoline, as well as oil."

Steel's War Record, American Iron and Steel Institute, June 1944.

"For sheer magnitude the expansion of steel capacity in the U. S. ranks among the greatest industrial construction programs of all time. Nearly 14,000,000 tons of new annual blast furnace capacity had been built since January 1940; 9,200,000 tons of new open hearth steel capacity and 4,500,000 tons of electric furnace steel capacity were made ready for production."

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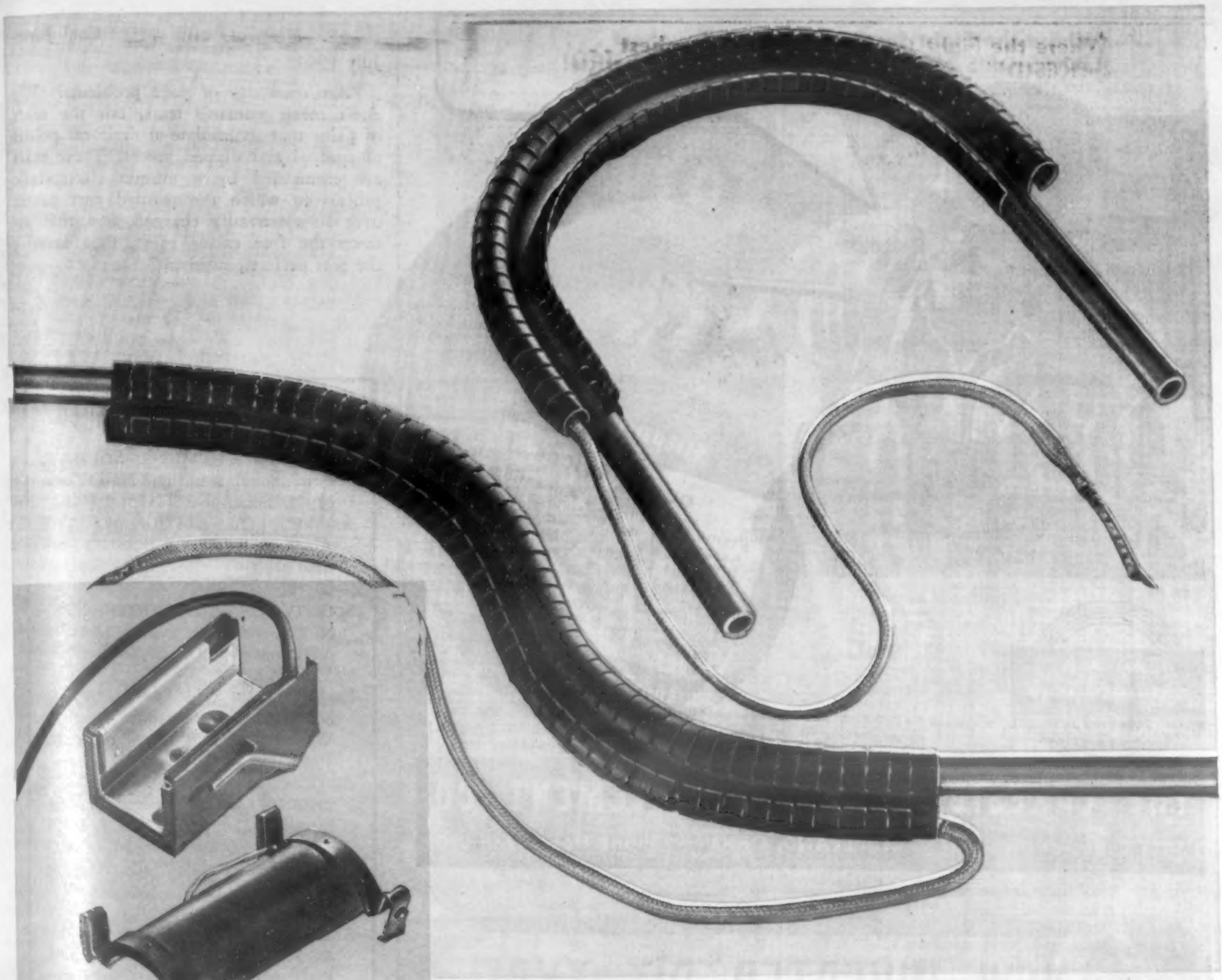

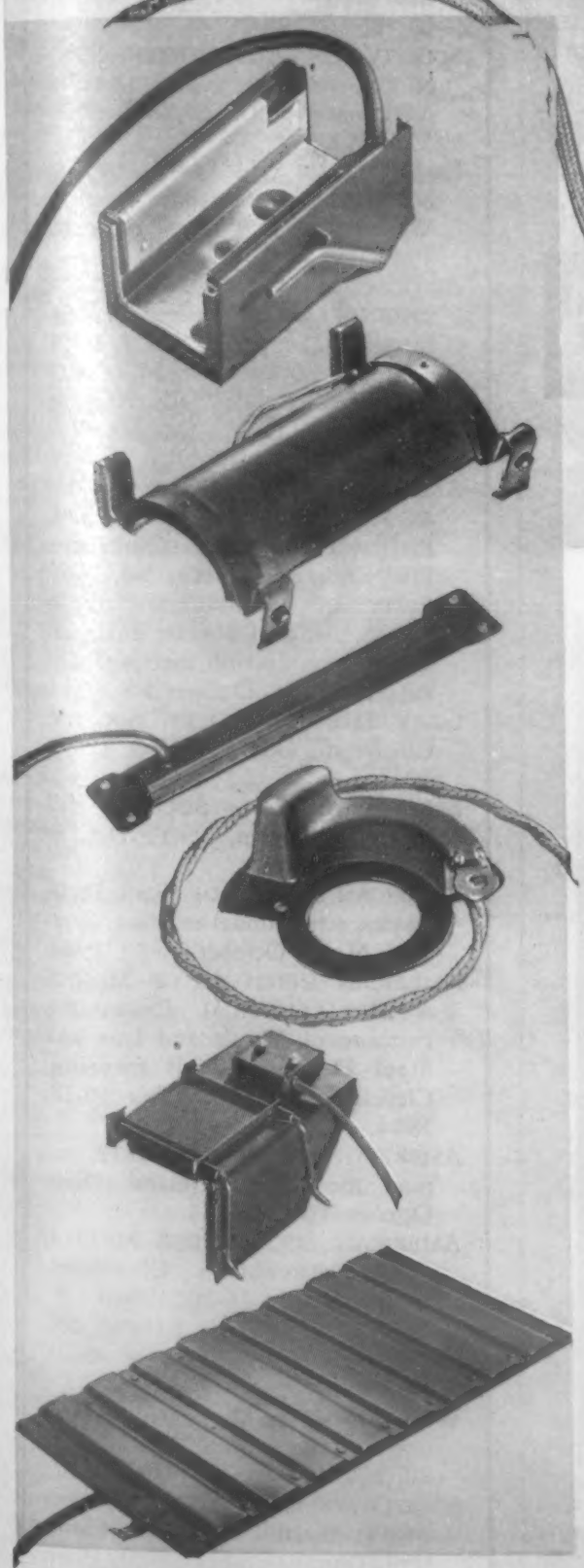

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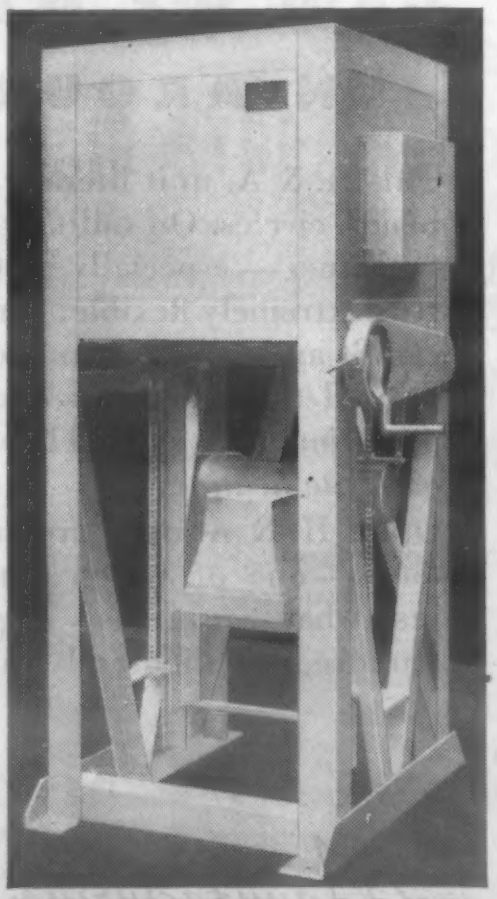

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Ohmite News, Ohmite Mfg. Co., June-July 1944.

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Meetings and Expositions

AMERICAN CHEMICAL SOCIETY, semi-annual meeting. New York, N. Y. September 11-15, 1944.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, annual meeting. Cleveland. September 11-16, 1944.

SOCIETY OF AUTOMOTIVE ENGINEERS, national tractor meeting. Milwaukee, Wis. September 13-15, 1944.

INSTITUTE OF THE AERONAUTICAL SCIENCES, air transport meeting. Washington, D. C. September 22, 1944.

ASSOCIATION OF IRON & STEEL ENGINEERS, annual meeting. Pittsburgh, Pa. September 25-27, 1944.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, fall meeting. Cincinnati, Ohio. October 2-5, 1944.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Electric Furnace Steel Committee. Pittsburgh, Pa. October 5-6, 1944.

SOCIETY OF AUTOMOTIVE ENGINEERS, national aircraft engineering and production meeting. Los Angeles, Calif. October 5-7, 1944.

GRAY IRON FOUNDERS' SOCIETY. Cincinnati, Ohio. October 10-11, 1944.

ELECTROCHEMICAL SOCIETY, fall meeting. Buffalo, N. Y. October 12-14, 1944.

AMERICAN SOCIETY OF TOOL ENGINEERS, semi-annual meeting. Syracuse, N. Y. October 12-14, 1944.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Institute of Metals and Iron and Steel Divisions, fall meeting. Cleveland, Ohio. October 16-18, 1944.

AMERICAN WELDING SOCIETY, annual meeting. Cleveland, Ohio. October 16-19, 1944.

AMERICAN SOCIETY FOR METALS, annual convention. Cleveland, Ohio. October 16-20, 1944.

NATIONAL METAL EXPOSITION. Cleveland, Ohio. October 16-20, 1944.

WIRE ASSOCIATION, annual convention. Pittsburgh, Pa. October 16-20, 1944.

SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS, fall meeting. Cleveland, Ohio. October 17-20, 1944.

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By Edwin F. Cone

More Chromium Iron

There has been a marked increase in the demand for the 12 to 14% Cr stainless steel in the past year. Data just recently published by the American Iron and Steel Institute show that the 1943 output of this grade was 98,997 net tons, an increase of 36,429 tons or 57.8% over the 1942 total of 62,568 tons. The 1943 total is a new record. By contrast there was a small decrease in the production of this grade in 1942 from that of 1941.

New High in Stainless Steel

Despite war restrictions on the use of nickel and chromium, data recently released by the American Iron and Steel Institute show that a new high was made in 1943 in the production of "stainless steel ingots" or the corrosion and heat-resisting alloys. The 1943 total was 457,448 net tons, an increase of 111,668 tons or 34.2% over the 1942 total, until then a record also.

Pig Iron Output Still Expanding

The pig iron output of American blast furnaces continues to expand. The production for the last 2½ yr. has been as follows in net tons:

	Total	*Tons per Mo.*
1942	60,903,304	5,075,275
1943	62,769,949	5,230,827
1944 (to July 1)	31,481,620	5,246,933

These data, as published by the American Iron and Steel Institute, include all ferroalloys and direct castings. A measure of the rapid war expansion is reflected by the fact that in 1939 the output was 35,677,097 tons or only 2,973,-091 tons per mo.

Plastics Versus Metals

There is no reason for miners and metallurgists to be alarmed at the inroads of plastics on metals in the post-war era, says Don Masson, technical editor of the Bakelite Corp. in an article "Plastics vs. Metals" in the August issue of *Mining and Metallurgy*. "Even today," he says, "the total yearly tonnage of plastic materials is approximately only 1% of steel, and only a small fraction of this might even be considered actually replacing steel. However, these figures must not be taken as indicating that the importance of plastics in fields hitherto considered exclusively the territory of metals is negligible—far from it. Considering the comparatively minute tonnage of plastics now being produced in comparison to the output of metals, the number of applications where plastics have augmented or aided the sale of metals is considerable."

The Tin Can Goes on the Radio

The Can Manufacturers Institute is now using the radio to make American consumers more aware of the tremendously important part which the steel and tin can plays in the life of the nation, whether in war or peace.

Drop in Student Engineers

As a result of the war and its effect on the over-all picture for all engineering branches in the United States and Canada, there has been a sharp decline in student engineering enrollment. According to the *Journal of Engineering Education*, the total of all engineers enrolled in the year 1941 to 1942 was 115,228. This contrasts with 52,131 on Oct. 3, 1943, resulting in a decline of 55% in all engineering branches, which include mining, chemical, civil, mechanical, electrical and other engineers.

Soldiers Returning to Steel Mills

One out of every 20 steel employees who were drafted into military service has already come back to work for his former company, according to a survey by the American Iron and Steel Institute. Since the Selective Service Law was passed late in 1940, about 214,000 steel employees went in the service. Of that total 10,100 have been released and gone back to their respective companies. About 600 more have returned to other steel companies.

Manpower in the Foundry Industry

Twenty per cent more castings are needed for third quarter than originally estimated. For the first half of 1944 production has not attained quotas set, states Donald M. Nelson. For brake shoes a 50% production boost is needed. Because of manpower shortage both the forge and malleable foundry industry are working at only 70% of capacity.

Going to Bat with Magnesium

Already plans and experiments are on foot for new uses of magnesium and its alloys after the war. The experimental production of magnesium baseball bats is one—some day the home run hitter may be accompanied by a metallic ring. Another experiment is the manufacture of small ladders of magnesium for use in the fruit orchards of the West.